Series 1961, No. 29

Issued August 1965

Soil Survey
THOMAS COUNTY NEBRASKA

UNITED STATES DEPARTMENT OF AGRICULTURE
Soil Conservation Service
and Forest Service
In cooperation with
UNIVERSITY OF NEBRASKA
Conservation and Survey Division

HOW TO USE THE SOIL SURVEY REPORT

THIS SOIL SURVEY of Thomas County will serve several groups of readers. It will help farmers and ranchers in planning the kind of management that will protect their soils and provide good yields; assist engineers in selecting sites for roads, buildings, ponds, and other structures; serve as a reference for students and teachers; aid foresters in managing woodlands; help prospective farmers, land appraisers, bankers, and real estate agents to decide the worth of a particular farm; and add to our knowledge of soil science.

Locating Soils

Use the index to map sheets at the back of this report to locate areas on the large map. The index is a small map of the county numbered to show where each sheet of the large map is located. When the correct sheet of the large map has been found, it will be seen that boundaries of the soils are outlined, and that there is a symbol for each kind of soil. All areas marked with the same symbol are the same kind of soil, wherever they occur on the map. The symbol is inside the area if there is enough room; otherwise, it is outside the area and a pointer shows where the symbol belongs.

Finding Information

This report contains sections that will interest different groups of readers, as well as some sections that may be of interest to all.

Ranchers and those who work with them can learn about the soils in the section "Descriptions of the Soils," and then turn to the section "Managing Rangeland," where the soils that support similar vegetation and need similar management have been placed in groups called range sites. In that section information on the principal plants on each range site and on predicted yields of herbage in favorable and unfavorable years is given.

Information on use of the soils for cultivated crops is given in the section "Capability Groups of Soils," where soils similar in needed management and response to that management have been placed in groups called capability units.

The "Guide to Mapping Units, Range Sites, and Capability Units" at the back of the report will simplify use of the map and report. This guide lists each soil and land type mapped in the county, and the page where each is described. It also lists, for each soil and land type, the range site and capability unit, and the pages where each of these is described.

Persons interested in woodland can refer to the section "Woodland and Windbreaks." In that section the soils in the county are grouped according to their suitability for trees, and factors affecting the management of woodland are explained.

Engineers will want to refer to the section "Engineering Properties of the Soils." Tables in that section show characteristics of the soils that affect engineering.

Scientists and others who are interested will find information about how the soils were formed and how they were classified in the section "Genesis, Classification, and Morphology of Soils."

Students, teachers, and other users will find information about soils and their management in various parts of the report, depending on their particular interest.

Newcomers in Thomas County will be especially interested in the section "General Soil Map," where broad patterns of soils are described. They may also be interested in the section "General Nature of the County" which gives additional information about the county.

* * * * *

Fieldwork for this survey was completed in 1961. Unless otherwise indicated, all statements in the report refer to conditions in the county at that time. The soil survey of Thomas County was made as part of the technical assistance furnished by the Soil Conservation Service to the Blaine-Thomas Soil and Water Conservation District.

Cover Picture: Cattle on lush native grass on the Sandhills in Thomas County.

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Contents

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SOIL SURVEY OF THOMAS COUNTY, NEBRASKA

BY LESTER E. SHERFEY, SOIL CONSERVATION SERVICE, AND CHARLES FOX AND JOHN NISHIMURA, FOREST SERVICE

UNITED STATES DEPARTMENT OF AGRICULTURE IN COOPERATION WITH THE UNIVERSITY OF NEBRASKA CONSERVATION AND SURVEY DIVISION

THOMAS COUNTY is near the center of the Sandhills region in Nebraska (fig. 1). The area measures 24 miles from north to south and 30 miles from east to west. The total area of the county is 458,240 acres. Elevation ranges from 2,690 feet above sea level near Halsey to 3,460 feet near the western border. The Dismal River flows through the southern part of the county, the Middle Loup River through the central part, and the North Loup River through the northeastern corner. The area consists of rolling, sandy soils that have a good cover of grass. Little of the acreage is cultivated. Most of the area is used for the production of beef cattle.

How This Soil Survey Was Made

Soil scientists made this survey to learn what kinds of soils are in Thomas County, where they are located, and how they can be used.

They went into the county knowing they likely would find many soils they had already seen, and perhaps some they had not. As they traveled over the county, they observed steepness, length, and shape of slopes; size and speed of streams; kinds of native plants or crops; kinds of rock; and many facts about the soils. They dug or bored many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it extends from the surface down to the material that has not been changed much by leaching or by roots of plants.

The soil scientists made comparisons among the profiles they studied, and they compared these profiles with those in counties nearby and in places more distant. They classified and named the soils according to uniform procedures. To use this report efficiently, it is necessary to know the kinds of groupings most used in a local soil classification.

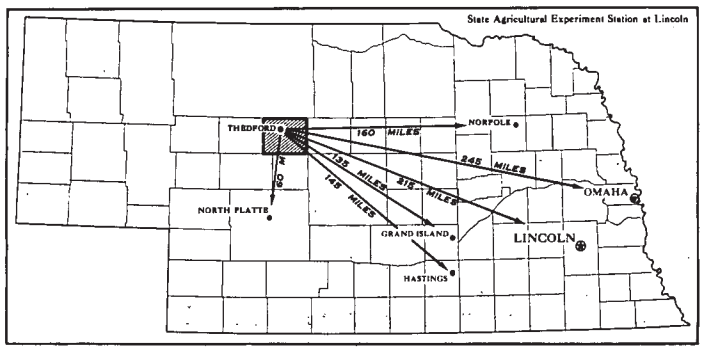

Figure 1.—Location of Thomas County in Nebraska.

Soils that have profiles almost alike make up a soil series. Except for different texture in the surface layer, all the soils of one series have major horizons that are similar in thickness, arrangement, and other important characteristics. Each soil series is named for a town or other geographic feature near the place where a soil of that series was first observed and mapped. Valentine and Dunday, for example, are the names of two soil series. All the soils in the United States having the same series name are essentially alike in natural characteristics.

Many soil series contain soils that are alike except for texture of their surface layer. According to such differences in texture, soil types are defined. Within a series, all the soils having a surface layer of the same texture belong to one soil type. Valentine fine sand and Valentine loamy sand are two soil types in the Valentine series. The difference in texture of their surface layers is apparent from their names.

Some soil types vary so much in slope, degree of erosion, number and size of stones, or some other feature affecting their use, that practical suggestions about their management could not be made if they were shown on the soil map as one unit. Such soil types are divided into soil phases. The name of a soil phase indicates a feature that affects management. For example, Valentine fine sand, hilly, consists of those areas of Valentine fine sand that are hilly and need management that takes this hilliness into account.

After a guide for classifying and naming the soils had been worked out, the soil scientists drew the boundaries of the individual soils on aerial photographs. These photographs show woodlands, buildings, field borders, trees, and other details that help in drawing boundaries accurately. The soil map in the back of this report was prepared from the aerial photographs.

The areas shown on a soil map are called mapping units. On most maps detailed enough to be useful in planning management of fields, a mapping unit is nearly equivalent to a soil type or a phase of a soil type. It is not exactly equivalent, because it is not practical to show on such a map all the small, scattered bits of soil of some other kind that have been seen within an area that is dominantly of a recognized soil type or soil phase.

In preparing some detailed maps, the soil scientists have a problem of delineating areas where different kinds of soils are so intricately mixed, and so small in size, that it is not practical to show them separately on the map. Therefore, they show this mixture of soils as one mapping unit and call it a soil complex. Ordinarily, a soil complex is named for the major soil series in it, for example, Dunday-Anselmo loamy fine sands, hummocky. Also, on most soil maps, areas are shown that are so rocky, so shallow, or so frequently worked by wind and water that they scarcely can be called soils. These areas are shown on a soil map like other mapping units, but they are given descriptive names, such as Blown-out land, and are called land types rather than soils.

While a soil survey is in progress, samples of soils are taken, as needed, for laboratory measurements and for engineering tests. Laboratory data from the same kinds of soils in other places are assembled. Data on yields of crops under defined practices are assembled from farm records and from field or plot experiments on the same kinds of soils. Yields under defined management are estimated for all the soils.

But only part of a soil survey is done when the soils have been named, described, and delineated on the map, and the laboratory data and yield data have been assembled. The mass of detailed information then needs to be organized in a way that it is readily useful to different groups of readers, among them farmers, ranchers, managers of woodland, engineers, and homeowners. Grouping soils that are similar in suitability for each specified use is the method of organization commonly used in the soil survey reports. Based on the yield and practice tables and other data, the soil scientists set up trial groups, and test them by further study and by consultation with farmers, agronomists, engineers, and others. Then, the scientists adjust the groups according to the results of their studies and consultation. Thus, the groups that are finally evolved reflect up-to-date knowledge of the soils and their behavior under present methods of use and management.

General Soil Map

As one travels over a county or other large tract it is fairly easy to see differences in the landscape from place to place. There are many obvious differences. Some of them are in shape, steepness, and length of slopes, in the course, depth, and speed of the streams, in the width of the bordering valleys, in kinds of wild plants, and in the kind of agriculture. With these more obvious differences there are others less easily noticed in the patterns of soils. The soils differ along with the other parts of the environment.

By drawing lines around the different patterns of soils on a small map, one may obtain a general map of the soils. Each kind of pattern is called a soil association. Such a map is useful to those who want a general idea of the soil, who want to compare different parts of a county, or who want to locate large areas suitable for some particular kind of farming or other broad land use. It does not show accurately the kinds of soils on a single farm or a small tract.

The soil associations, or kinds of soil patterns, in Thomas County, are shown on the colored map at the back of this report. The areas are named for the major soil series in them, but soils of other series may be present in any of the areas. Also, the major soil series of one area may occur in the others. Each general area has a distinct pattern of soils, and the soil differences are important to the farms within each general area.

The five soil associations in the county are shown on the general soil map on the basis of the kinds and proportions of soils that occur in each. A rancher flying over Thomas County from the southeast would see these associations as shown in figure 2.

Choppy sandhills make up most of the southern half of the county, and choppy sandhills and intervening swales are in the southwestern corner. Rolling sandhills and rolling sandhills and swales are in the northern part. The Middle Loup River and its flood plain, about 1 mile wide, cross the county from Seneca to Halsey. The flood plain of the North Loup River just touches the northeastern corner of the county.

The individual soil associations in the county are described in the pages that follow. Readers who want more information about the soil series in these associations can refer to the sections, "Descriptions of the Soils" and "Detailed Descriptions of Soil Series."

1. Valentine, Rolling, Soil Association: Rolling Sandhills

This soil association consists mainly of broad areas of smooth, round-topped hills broken in places by small areas of steep, catstepped, peaked hills and intervening small valleys. It is mostly in the northern part of the county on both sides of the Middle Loup River, but a comparatively small area is in the northeastern part.

Valentine fine sand, rolling, makes up about 85 percent of this association. It is on the smoother hills. Valentine fine sand, hilly, on the steep, rough hills, makes up about 14 percent of the association. The rest of the association consists of a few small areas of Rough broken land along slopes of the river valley and of small areas of Anselmo and Dunday soils on lower slopes of the valley. The largest area of Rough broken land is near Seneca, where it extends westward into Hooker County. It is characterized by a distinct drainage system.

In this association the ranches are mostly small or medium in size. The ranchers use the alluvial soils along the river valley for hay and crops.

2. Valentine, Rolling-Anselmo Soil Association: Rolling Sandhills and Swales

This soil association, in the northern and the western parts of the county, consists of scattered, nearly level to gently rolling valleys, of low, smooth hills, and of a few, small areas of peaked hills.

Valentine fine sand, rolling, makes up about 80 percent of the association. It is on the hills and also, in some places, in the gently rolling valleys. In most places it is a deep, fine sand, but in a few places on the south or east side of a valley, the surface soil is loamy fine sand to a

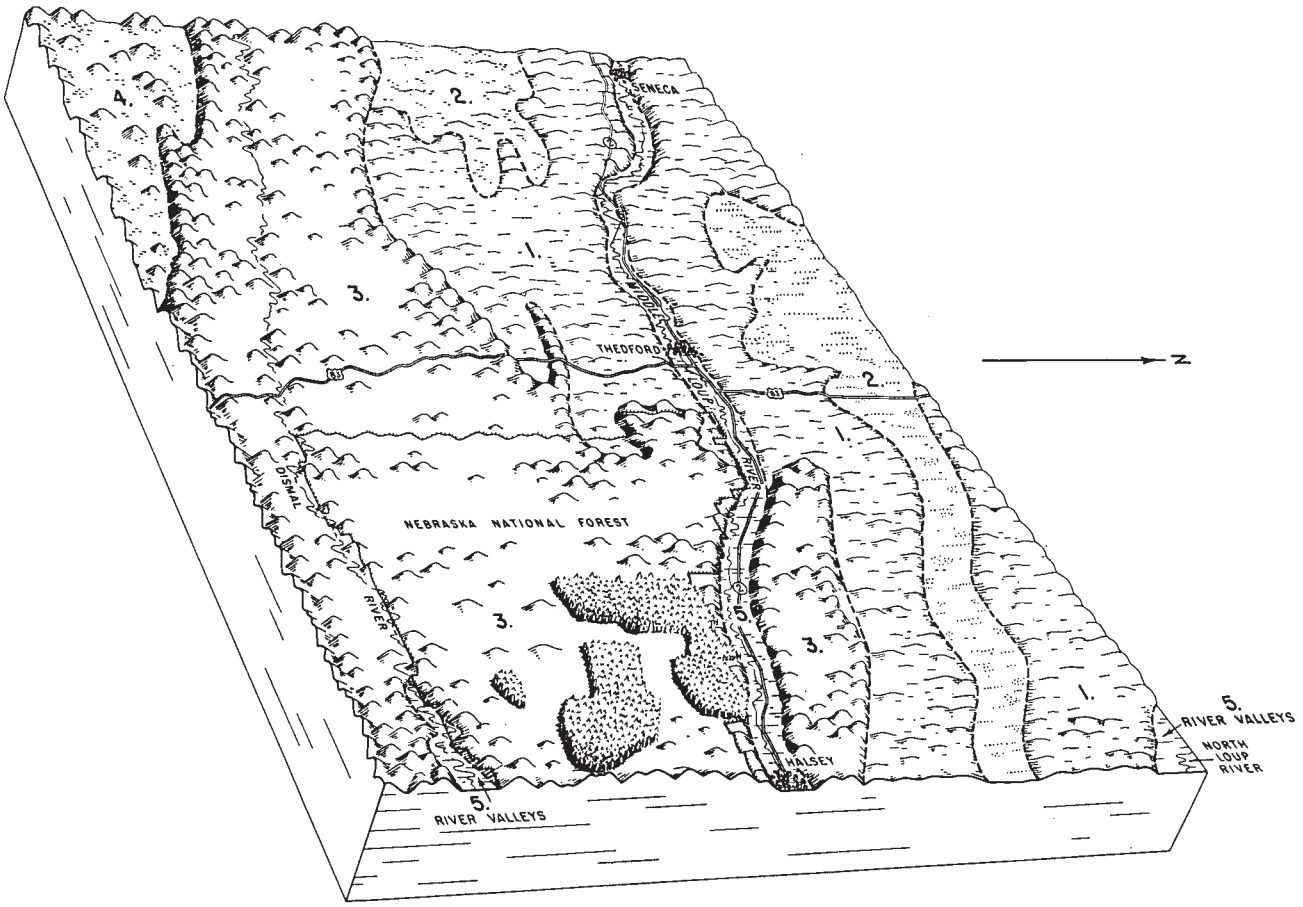

Figure 2.—**Sketch of the soil associations in Thomas County: 1. Valentine, rolling; 2. Valentine, rolling-Anselmo; 3. Valentine, hilly; 4. Valentine, hilly-Dunday; 5. Dunday-Loup.**

depth of a few inches. About 5 percent of Valentine fine sand, rolling, has been cultivated and needs to be seeded to desirable grasses.

Dunday and Anselmo soils, which make up about 10 percent of the association and most of the cultivated acreage, are in the nearly level to gently rolling valleys. About one-fourth of the acreage of the Dunday and Anselmo soils is cultivated, and an equal acreage has been cultivated but is now being returned to pasture.

Valentine fine sand, hilly, on steep faces of dunes, or in a few places on high steep hills, occupies the rest of this association. Here the ranches are of small and medium size.

3. Valentine, Hilly, Soil Association: Choppy Sandhills

This association makes up the roughest, most rugged part of the county. It occupies broad areas on both sides of the Dismal River and extends northward across the Middle Loup River in the eastern part of the county. The areas consist of belts of steep, rough dunes separated by belts of lower, smoother dunes. The valleys are small and narrow.

In the southeastern part of the county, where this association joins association 5, there are a few small areas of subirrigated soils. In the western part of the county, on slopes along the Dismal River, Rough broken land is more extensive. In adjacent Hooker County, the proportion of Rough broken land further increases.

Valentine fine sand, hilly, on the larger and steeper dunes, makes up about 55 percent of the association. Valentine fine sand, rolling, on the lower and smoother dunes, makes up about 44 percent. Dunday soils are in a few small areas in the larger upland valleys. There are also small areas of Rough broken land, and of Anselmo, Hord, and alluvial soils along the Dismal River.

Almost none of the acreage in this association is cultivated. The Bessey Division of the Nebraska National Forest occupies the eastern part of the association. The rest is mostly in medium and large ranches.

4. Valentine, Hilly-Dunday Soil Association: Choppy Sandhills and Swales

This soil association is an area of high, steep dunes and intervening, fairly large, nearly level valleys. Lower, rounded dunes are in the areas transitional from the valleys to the high dunes, and in places these rounded dunes separate the nearly level areas in the valley. The association is in the southwestern part of the county and extends into adjacent Hooker, McPherson, and Logan Counties.

Valentine fine sand, rolling, is on the smoother dunes and makes up about 60 percent of the total acreage. Valentine fine sand, hilly, is on the higher, steeper, rougher dunes, some of which are more than 200 feet high. This hilly Valentine soil occupies about 30 percent of the association. Nearly level to gently rolling Dunday soils are on the valley floors, and a few, small areas of Anselmo soils are in the eastern part of the association. The Dunday and Anselmo soils make up 10 percent of the total acreage. About 30 percent of the Dunday soils is cultivated, and an equal acreage was once cultivated but is now in weedy grasses. The rest of the Dunday acreage is in native grasses. Most of this association is in large ranches.

5. Dunday-Loup Soil Association: River Valleys

Most of this soil association is along the Middle Loup River, but a small area is along the North Loup River and another is along the Dismal River in the eastern part of the county. The association occupies the nearly level to gently rolling terraces and river bottoms.

The well-drained, Meadin-Dunday loamy fine sands are on the higher and deeper terraces, and Meadin loamy sand, also well drained, is on somewhat lower terraces. The Meadin-Dunday loamy fine sands make up about 37 percent of the association, and Meadin loamy fine sand, about 14 percent. All of Meadin loamy fine sand is used for pasture.

In a few places on terraces in the extreme eastern part of the county are soils formed from material of Tertiary age. On these terraces the nearly level areas are occupied by Hord soils, the gently sloping areas by Anselmo soils and Hord soils, and the steep areas by Gravelly land. These soils make up only a small part of this association, but they occupy more than half of the valley of the North Loup River.

The imperfectly drained Elsmere soils occupy the sandy terraces and make up about 5 percent of the association. About one-fourth of the acreage of the Elsmere soils is cultivated, and most of the rest is in hay. The Wann soils occupy similar positions but have a finer texture than the Elsmere soils. They make up about 3 percent of the association. About two-fifths of the acreage of the Wann soils is cultivated, and the rest is in native grass.

The poorly drained Loup soils, on river bottoms, make up about 15 percent of the association, and Marsh, on the lowest river bottoms, about 11 percent. The Loup soils are used mostly for hay. Marsh is generally covered with water and is suitable only for wildlife habitat.

Rivers make up about 13 percent of the association, and lakes about 2 percent. The water in the rivers is clear and of excellent quality, but the bedload of sand is heavy. Lakes occupy several areas along the river channels. Most of these are old oxbows and are generally fairly shallow. A few lakes formed as the result of pumping gravel from areas for industrial use; these are generally fairly deep.

In the western part of the valley of the Middle Loup River, the association is fairly narrow. Near the county line the nature of the valley changes, and in adjacent Hooker County this valley is narrower and its slopes are mostly Rough broken land.

This soil association is the most accessible in Thomas County. It contains most of the tillable soils and most of the high-producing hayland in the county. It also has the most abundant and easily available supply of water. Consequently, sites in this association are desirable, and many of the ranch headquarters are located here. There are a number of towns, a major highway, and a railroad in this association.

Descriptions of the Soils

Thomas County is part of a large, sandy grassland made up of dunes of various sizes broken by small to fairly large, nearly level valleys (fig. 3).

All the soils in the county developed in sand deposited by wind or water. Most of the soils in the valleys are influenced by silt washed or blown from the Ogallala formation. In most places the silt has been reworked by wind or water and mixed with the sand. In other places nearly undisturbed material from the Ogallala formation is in the subsoil and substratum. The Ogallala formation underlies the windblown fine sand throughout the county, but it is exposed in some places along the slopes of the river valley. It consists of layers that range in texture from gravel to clay loam.

Most of the soils in this county are well-drained fine sands and are not suited to cultivation. Less than 10 percent of the acreage has ever been cultivated, and much of this has been returned to grass. More than 95 percent of the area is used for hay or pasture, which provides grazing for beef cattle.

In this section each series of soils is described and important features that apply to all the soils in the series are discussed. The location of the soils in the county and their position in the landscape are given, a comparison with nearby soils or similar soils is made, and the use of the soils is briefly noted.

Following the description of each series is a description of each soil in the series. Generally, these descriptions tell how the various layers or horizons of the soil profile differ from the layers described as representative of the series. Unless otherwise stated, the colors given describe the surface layer when dry and the underlying layers when moist. The description of each soil also tells about the suitability of the soil for agriculture, its use, and something about its management needs.

A detailed description of each soil series is provided in the section "Detailed Descriptions of Soil Series." For more general information about the soils, the reader can refer to the section "General Soil Map," which describes the broad patterns of soils in the county.

Some of the terms used in the soil descriptions are defined in a preceding section "How This Soil Survey Was Made." Other terms are described in the Glossary. The acreage and proportionate extent of each soil mapped is given in table 1. The location and extent of the soils in the county are shown on the detailed soil map at the back of this report.

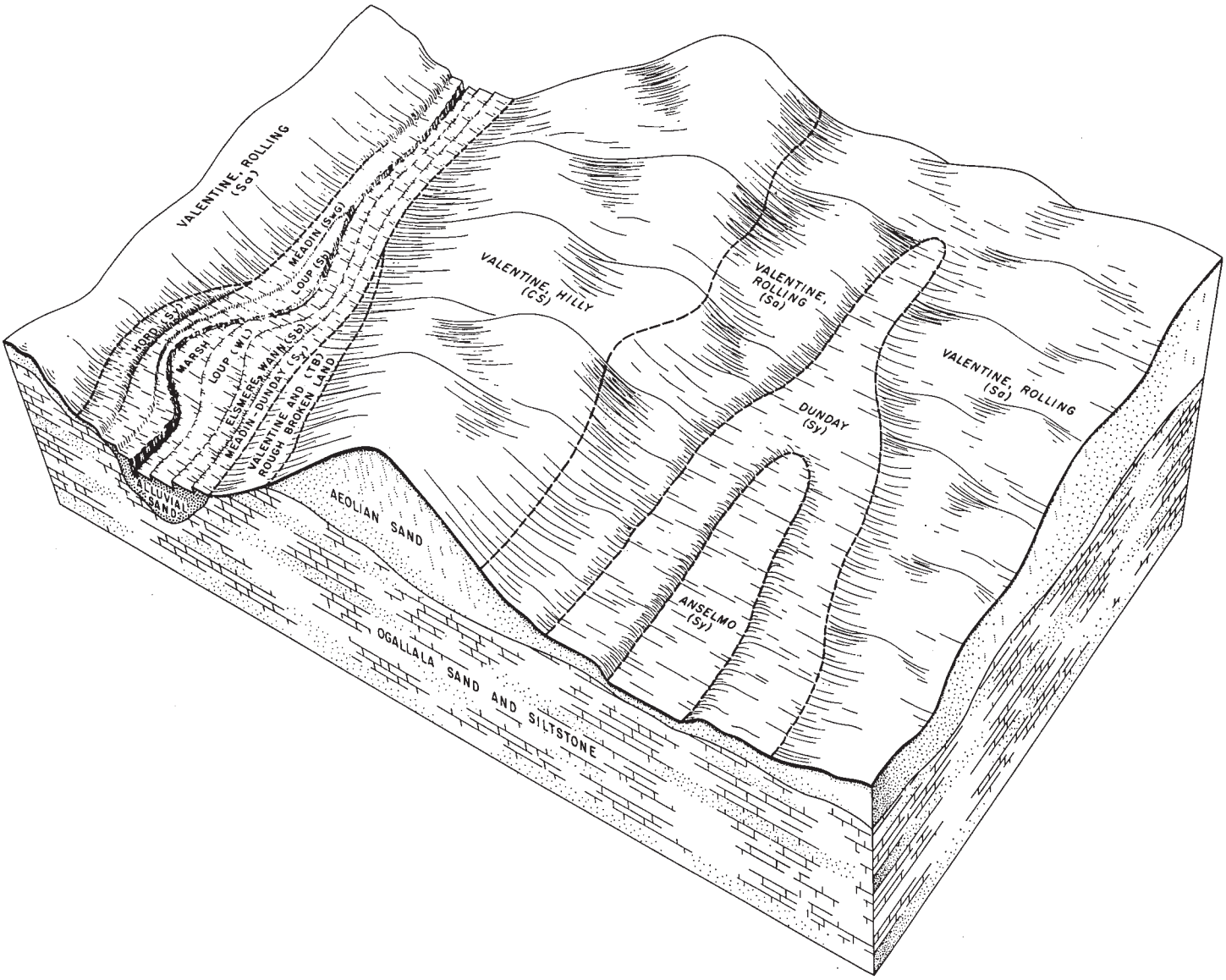

Figure 3.—**Diagram showing typical soils and parent materials in Thomas County. Symbols below soil names identify range sites as follows: (Sa) Sands; (CS) Choppy Sands; (Sy) Sandy; (Sb) Subirrigated; (WL) Wet Land; (TB) Thin Breaks; (SwG) Shallow to Gravel.**

Anselmo Series

The Anselmo series is made up of deep, dark, sandy soils that have finer textured layers in the lower part of the profile. These soils are in enclosed valleys in the uplands and along the slopes of river valleys. Most of the acreage is in the northeastern part of the county. The native vegetation was mid and tall grasses.

The surface layer is brown to dark grayish-brown loamy sand to sandy loam. It ranges from 6 to 24 inches in thickness, but it averages between 10 and 12 inches except in winnowed areas. In these areas some spots are thinner and others are thicker. Below the surface layer is a lighter colored layer, which is transitional to the light-colored substratum. The substratum is fairly uniform sandy loam in some places. In other places it consists of alternate layers of fine sands or ranges from fine sandy loam to silt loam in texture. In some places the substratum is calcareous.

Anselmo soils have a finer textured subsoil and substratum than the Dunday soils. Their surface soil is thicker and darker than that of the Valentine soils, and they are finer textured throughout than those soils.

The Anselmo soils are well drained. They take in water rapidly and release it readily. Nevertheless, in places water accumulates in small amounts in low spots, following a heavy rain or rapid melting of snow.

These soils are among the most productive in the uplands for crops, but they need protection from wind erosion.

TABLE 1.—*Approximate acreage and proportionate extent of soils*

Soil	Acres	Percent
Anselmo fine sandy loam	344	0.1
Anselmo fine sandy loam, hummocky	831	.2
Blown-out land	2,737	.6
Dunday loamy fine sand	552	.1
Dunday loamy fine sand, hummocky	4,613	1.0
Dunday-Anselmo loamy fine sands, hummocky	2,218	.5
Elsmere loamy fine sand	773	.2
Gravelly land	135	(1)
Hord complex, sandy variants	324	.1
Loup loam	804	.2
Loup fine sand and Marsh	849	.2
Marsh	1,045	.2
Meadin loamy sand	538	.1
Meadin-Dunday loamy fine sands	2,243	.5
Meadin-Dunday loamy fine sands, hummocky	1,114	.2
Valentine fine sand, hilly	109,447	23.9
Valentine fine sand, rolling	325,546	71.0
Valentine loamy sand, hummocky	945	.2
Valentine soils and Rough broken land	983	.2
Wann fine sandy loam	517	.1
Rivers and lakes	1,682	.4
Total	458,240	100.0

[1] Less than 0.1 percent.

Anselmo fine sandy loam (An) has layers like those described for the series. It is nearly level and on floors of valleys, and it is fairly uniform wherever it occurs. Slopes range from 0 to 3 percent.

Most of this soil is cultivated, and it is one of the most productive soils in the uplands. The soil is subject to moderate wind erosion if left unprotected. Growing cover crops and leaving crop residues on the soil help control wind erosion. Capability unit IIe–3; Sandy range site.

Anselmo fine sandy loam, hummocky (AnB) is in hummocky areas and has short slopes that range from 3 to 6 percent. Its profile is similar to that described for the series, but the surface layer is more variable in thickness. In many small areas the surface layer is almost gone. Other small areas have a cover of soil material, blown from areas nearby, that ranges from a few to many inches in thickness. In some places the covering material cannot be distinguished from the original surface layer, but in other places it is lighter colored and coarser textured. Winnowing by wind has removed organic material and the finer particles of soil in some places. Severely eroded areas and blowouts are shown by symbols on the detailed soil map.

Included with this soil in mapping are small areas of Dunday and Valentine soils.

Anselmo fine sandy loam, hummocky, is subject to severe wind erosion. The use of stubble-mulch tillage and wind stripcropping and the growing of cover crops in winter are needed on all areas used for crops. Capability unit IVe–3; Sandy range site.

Blown-out Land (B)

This miscellaneous land type consists of areas of loose, unstabilized sand blown about by the wind. The areas are nearly level to vertical.

The blowouts are the result of wind erosion on any of the soils mapped in the county, but they are most common in Valentine soils. Small blowouts generally result from destruction of vegetation because of excessive trailing by livestock. Larger blowouts are caused by excessive trampling by livestock around windmills or by cultivating areas without adequate protection from the wind. Even though cultivation is discontinued when blowouts develop, many of them continue to erode. A typical blowout is shown in figure 4.

A blowout consists of one or more areas from which soil has been removed by wind. It is generally shaped like a bowl or saucer, is a few to many feet deep, and has vertical banks on one or two sides. A hummock of accumulated sand is adjacent to each area of removal. In some places the area of accumulated soil has been stabilized by vegetation and only the area from which soil was removed remains bare.

Blowouts can be stabilized if the areas are seeded and mulched and livestock is excluded. When they are stabilized, blowouts can be managed like the surrounding soils. Capability unit VIe–5; Sands range site.

Dunday Series

In the Dunday series are deep, dark, nearly level to rolling soils that are noncalcareous. These soils are in enclosed valleys and on stream terraces in the uplands. The native vegetation was mid and tall grasses.

The surface layer, a brown to dark grayish-brown loamy fine sand, is 6 to 24 inches thick. It is thinner in windblown areas and thicker where soil material from other areas has accumulated. Below the surface layer is 8 to 12 inches of material that in color and texture is transi-

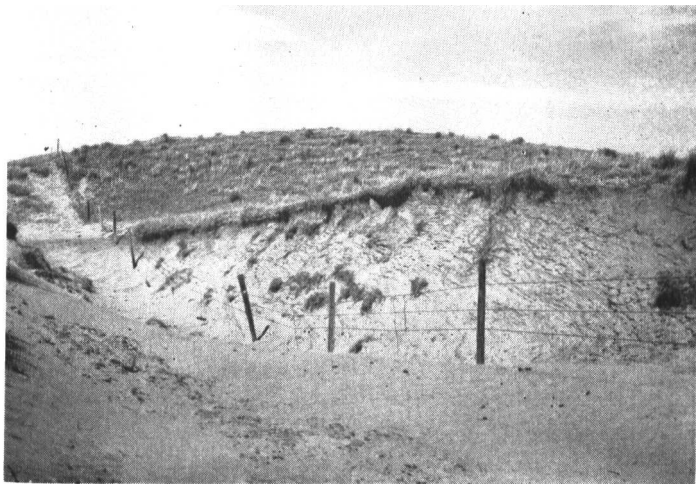

Figure 4.—A blowout in a Valentine soil caused by cattle trailing along a fence; the vertical bank and accumulation of sand are typical.

tional to the substratum. The substratum is a very pale brown to pale-brown fine sand.

Dunday soils have a coarser textured subsoil and parent material than the Anselmo soils. They have a thicker and darker surface soil than the Valentine soils.

The Dunday soils are well drained and have low water-holding capacity. They absorb water rapidly, release it readily, and are somewhat droughty. Nevertheless, in places small amounts of water accumulate in low spots after a heavy rain or rapid melting of snow.

These soils are fairly productive of crops if well managed, and about three-fourths of the acreage has been cultivated at some time. Special practices are needed to protect these soils from wind erosion.

Dunday loamy fine sand (Du) has layers like those described for the series. It is a nearly level soil on floors of valleys. Slopes range from 0 to 3 percent.

About one-fifth of the acreage of this soil is cultivated. The rest is in native grass. This soil has a higher water-holding capacity than any of the other Dunday soils in the county and is more productive. It is subject to severe wind erosion. The growing of rye or other cover crops in winter, following a row crop, and the use of stubble-mulch tillage and wind stripcropping help to control soil blowing. Capability unit IVe–5; Sandy range site.

Dunday loamy fine sand, hummocky (DuB) has slopes of 3 to 6 percent. It is similar to Dunday loamy fine sand, but the thickness of its surface layer is more variable.

Included with this soil in mapping are many small areas of Valentine soils.

About a third of Dunday loamy fine sand, hummocky, is now cultivated, and the rest has been cultivated at some time. This soil is not so productive as the other Dunday soils. The included Valentine soils are less fertile than this soil; they also blow more easily and thus provide centers from which erosion damage radiates. The growing of cover crops in winter and the use of stubble-mulch tillage and wind stripcropping are needed in all cropped areas. Capability unit IVe–5; Sandy range site.

Dunday-Anselmo loamy fine sands, hummocky (DAB) has slopes of 3 to 6 percent and occurs on hummocky to gently sloping valley floors. It consists of an association of Dunday and Anselmo soils and of soils that are intermediate in texture between these two soils.

The surface layer is loamy fine sand. Below, the layers are variable. They range from loamy fine sand through stratified loamy sand and fine sandy loam to uniform fine sandy loam.

Included with this mapping unit are a few small areas of Valentine soils on the higher hummocks.

About a third of Dunday-Anselmo loamy fine sands, hummocky, has been cultivated at some time but is now used as pasture, and about another third is now being cultivated. The areas never cultivated are all in native pasture.

This soil is subject to severe wind erosion. Old, cultivated fields should be reseeded to adapted species of native grasses. Capability unit IVe–5; Sandy range site.

Elsmere Series

The Elsmere series is made up of deep, dark, nearly level, very sandy soils that are imperfectly drained. These soils are on terraces or in upland valleys. In most places they have a thin, calcareous layer just above the water table, which is at a depth of 18 to 48 inches. Elsmere soils developed under tall grasses in alluvial sands where the supply of water was adequate and dependable.

The surface layer is dark-gray loamy fine sand. It ranges from 6 to 16 inches in thickness, but it averages between 8 and 10 inches. Below the surface layer is 2 to 8 inches of material that in color and texture is transitional to the substratum. The substratum is white or light-gray sand or sand and gravel.

These soils are adjacent to the Loup soils, but they are lighter colored and better drained than those soils. They also adjoin the well-drained Meadin, Dunday, and Valentine soils.

Most areas of Elsmere soils respond favorably to irrigation, but irrigation is difficult and expensive to apply because of the low water-holding capacity of the soils. Blowing is a hazard if the cover is removed.

Elsmere loamy fine sand (Ea) is the only soil of the Elsmere series mapped in the county. It has slopes of 0 to 3 percent.

Approximately 25 percent of the acreage of this soil is cultivated; the rest is in native grass. A cover that provides protection from blowing is needed on the soil at all times. Yields are high, but they are even higher if fertilizer is applied in the kinds and amounts indicated by soil tests and field trials. Capability unit IVw–5; Subirrigated range site.

Gravelly Land (Gv)

This miscellaneous land type consists of variable material. It ranges from nearly pure gravel to 4 to 6 inches of loamy sand underlain by gravel (fig. 5). The areas are on exposed Tertiary gravel beds on slopes of the North Loup River Valley. Gravelly land has slopes that range from 3 to 25 percent and has a definite drainage system.

In most places Gravelly land consists of deep beds of gravel. The spaces between the gravel in the upper 10 to 18 inches of the material are filled with loamy fine sand.

Included with this land type in mapping are a few small areas of Valentine soils.

Gravelly land is droughty and supports a thin stand of short grass and of drought-tolerant forbs. Maintaining a good stand of native grass helps to control erosion. Capability unit VIIs–4; Shallow to Gravel range site.

Hord Series

In the Hord series are deep, dark, nearly level, noncalcareous soils that are well drained. These soils are on terraces of Tertiary age in valleys of the North Loup River and of the eastern part of the Dismal River. The native vegetation was mid and tall grasses.

The surface layer is grayish-brown loamy fine sand and ranges from 4 to 24 inches in thickness, but in most places it is 8 to 12 inches thick. Below the surface layer is 1 foot to many feet of silt loam to clay loam that rests on sand and gravel.

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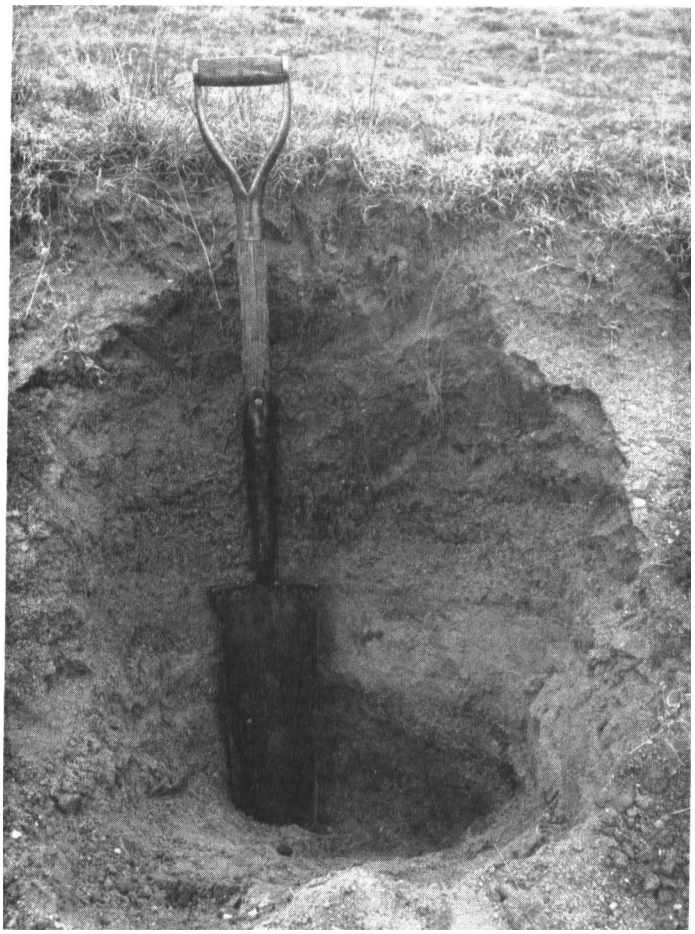

Figure 5.—**Profile in Gravelly land under a sparse cover of short grass.**

Hord soils have a finer textured subsoil than the Anselmo and the Wann soils, and they are better drained than the Wann soils.

Hord complex, sandy variants (Hx) is the only unit of the Hord series mapped in the county. Slopes are 0 to 3 percent.

Most of the acreage of this mapping unit is used for pasture. The soils are moderately productive of crops if adequate cover that provides protection from blowing is maintained. The use of stubble-mulch tillage and wind stripcropping and the growing of cover crops in winter help to control wind erosion. Fertilizer should be applied in the kinds and amounts indicated by soil tests and field trials. Capability unit IVe–5; Sandy range site.

Loup Series

The Loup series consists of dark-colored, poorly drained soils. These soils are on river bottoms in the Sandhills of Nebraska (fig. 6). They developed in alluvial sands where the water table was high and under a dense growth of plants that tolerated moisture.

The surface layer is very dark grayish brown to black and ranges from fine sand to clay loam. It is 2 to 14 inches thick, and in most places it is covered with a layer of grayish-brown, partly decomposed organic matter 1 to 4 inches thick. In some places there is a calcareous layer in the layer of organic matter or in the surface layer below. The surface layer rests on a substratum of gray to dark grayish-brown fine sand or on a layer transitional to that material. The transitional layer, if present, is 1 to 4 inches thick and its color and texture are intermediate between that of the surface soil and that of the substratum. In some places the transitional layer is finer textured than the material above or below. The boundary between the surface layer and underlying material is abrupt and smooth. In places the substratum grades to coarse sand and gravel at a depth below 18 inches.

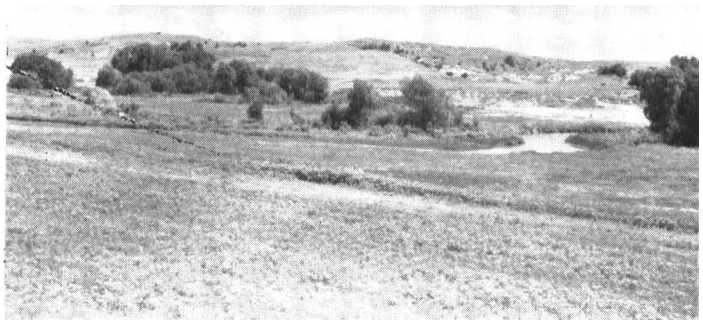

Figure 6.—**Typical view of Loup soils along the river; Valentine soils and Rough broken land are in the background.**

These soils occur with soils of the Elsmere series, which are imperfectly drained and with the Meadin soils, which are well drained. They also are associated with Marsh, which is covered with water most of the time.

Loup soils are too wet for cultivation because the water table is less than 24 inches from the surface most of the time. Alsike clover is a valuable pasture plant on these soils.

Loup loam (Lm) has layers like those described for the series. It has slopes of 0 to 1 percent and is at slightly higher elevations than Loup fine sand and Marsh, with which it is closely associated.

Some areas of this soil are as much as 40 percent of Loup fine sand and Marsh. Also included are small areas of Elsmere loamy fine sand.

Loup loam is too wet for cultivation. The vegetation is predominantly native tall grass used for hay. Yields increase if the areas are overseeded with alsike clover and if fertilizer is applied. The fertilizer should be applied in the kinds and amounts indicated by soil tests and field trials. Capability unit Vw–1; Subirrigated range site.

Loup fine sand and Marsh (LdM) is at slightly lower elevations and has poorer drainage than the associated Loup loam. Slopes are 0 to 1 percent. Except for the fine sand surface layer, the layers in Loup fine sand are similar to those described for the Loup series.

This complex consists mainly of Loup fine sand and of small areas of Marsh, of Loup loam, and of soils of the

Elsmere and Meadin series. In some places Loup loam makes up as much as 30 percent of an area and other soils and Marsh make up as much as 10 percent.

Loup fine sand and Marsh is too wet for cultivation. The vegetation is sedges and aquatic grasses used mainly for hay. Capability unit Vw–5; Wet Land range site.

Marsh (M)

Marsh consists of nearly level areas that are along rivers and are submerged most of the time. In most places the soil material is sand, but in many places the sand is covered by organic matter that varies in thickness and in state of decomposition.

Marsh supports a thick stand of cattails, rushes, willow brush, and other aquatic plants, but little of the vegetation is utilized. The areas may be under open water in wet seasons, and in dry seasons may have no water on them. The size of some areas has been reduced by artificial drainage, and the drained areas were mapped with soils of the Loup series. Capability unit VIIIw–1; not assigned to a range site.

Meadin Series

The Meadin series is made up of nearly level, very sandy soils that are shallow and moderately deep over gravel. These soils are on terraces. Slopes are 0 to 3 percent. The native vegetation was mid and short grasses.

The surface layer ranges from loamy sand to loamy fine sand. It ranges from 6 to 12 inches in thickness, but on the average it is about 8 inches thick. Below the surface layer is a lighter colored fine sand, 0 to 24 inches thick, that rests on the substratum of nearly white alluvial sand and gravel (fig. 7).

Meadin soils have a substratum that is coarser textured and nearer the surface than that of the Dunday soils. They are well drained, unlike the Elsmere soils, which are imperfectly drained, and they have more uniform surface layers than Gravelly land, which is sloping.

Meadin loamy sand (Md) has layers like those described for the series. Slopes are 0 to 3 percent, and coarse sand or gravel is at a depth between 8 and 20 inches. The native vegetation was predominantly short grasses.

Included with this soil in mapping are a few small areas of Elsmere soil.

Meadin loamy sand is very droughty. It is subject to severe wind erosion if it is not protected. Controlling grazing helps to maintain a protective cover of native grasses. Capability unit VIIs–4; Shallow to Gravel range site.

Meadin-Dunday loamy fine sands (MD) consists of nearly level soils on terraces. Slopes are 0 to 1 percent. This unit is made up of Dunday loamy fine sand and of small, irregular, and narrow areas of Meadin loamy sand. In many places the soil material consists of intergrades between the two soils, and the substratum of sand and gravel is at a depth of 20 to 36 inches. Most of the Dunday soil is underlain by alluvial sand and gravel at a depth of 3 to 6 feet.

About half the acreage of this unit is cultivated, and the rest is in native pasture. Productivity is slightly lower than on Dunday loamy fine sand because these soils are slightly more droughty. A protective cover that prevents blowing is needed on this unit. Capability unit IVe–5; Sandy range site.

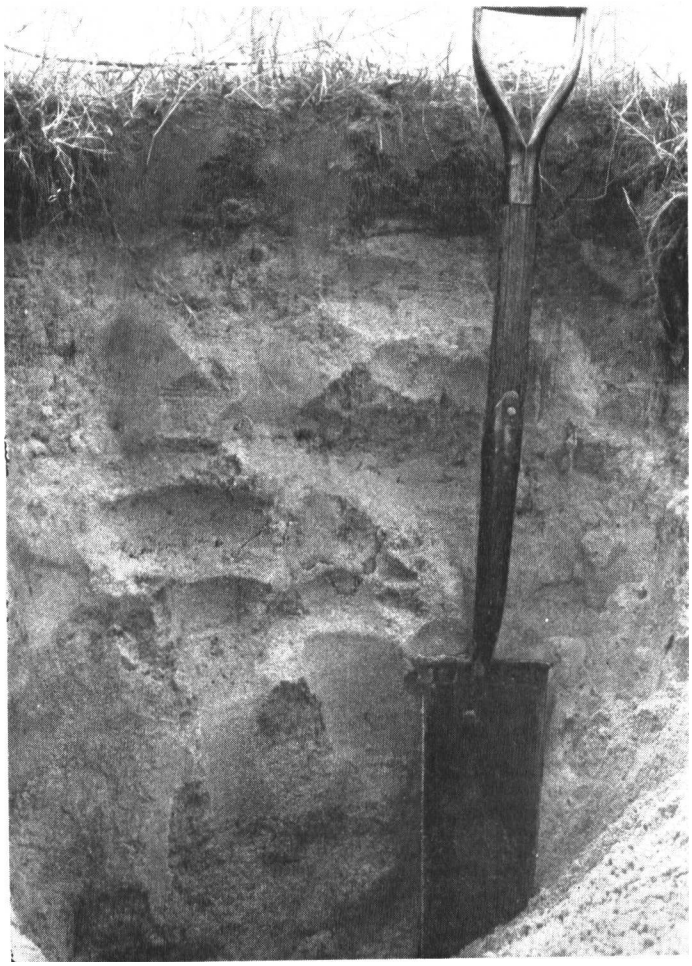

Figure 7.—**Profile of Meadin loamy sand, which has a thin surface layer underlain by sand and gravel.**

Meadin-Dunday loamy fine sands, hummocky (MDB) has slopes of 1 to 3 percent, but it is otherwise similar to Meadin-Dunday loamy fine sands. The areas are on channeled or hummocky terraces.

Included with this unit in mapping are small areas of Valentine soil on hummocks.

About 40 percent of the acreage of these soils is cultivated, and the rest is in native grass. These soils are slightly less productive than Dunday loamy fine sand. They blow readily if they are left bare. It therefore is necessary to keep growing crops or crop residue on the soils, to use stubble-mulch tillage, and to grow cover crops in winter on all areas used for crops. Capability unit IVe–5; Sandy range site.

Valentine Series

The Valentine series is made up of deep, loose, sandy soils that are well drained and noncalcareous. These soils are gently rolling to very steep and have catstepped slopes. The native vegtation was tall and mid grasses.

The surface layer ranges from grayish-brown fine sand, 0 to 10 inches thick, to loamy fine sand, 0 to 6 inches thick.

The material underlying the surface layer is fine sand transitional in color to the very pale brown sand below.

Valentine soils have thinner and coarser surface layers than the Dunday, Hord, or Anselmo soils. Their substratum is coarser than that of the Hord or Anselmo soils.

Valentine fine sand, hilly (VaD) has layers similar to those described for the series. Slopes are generally more than 16 percent and are catstepped. The darkened surface layer is less than 6 inches thick.

This soil is closely associated with Valentine fine sand, rolling, and in places contains as much as 45 percent of that soil in areas too small to delineate on the map. Also included are small, narrow areas of Anselmo, Dunday, and Elsmere soils and areas of Loup soil, of Marsh, and of Rough broken land along rivers. Severely eroded areas and blowouts too small to map separately are shown by symbols on the detailed soil map.

Valentine fine sand, hilly, is all in native grass or trees. It is less productive than Valentine fine sand, rolling, and requires better management to maintain enough cover to prevent it from blowing. Controlling grazing helps to maintain a protective cover of native grasses. Capability unit VIIe–5; Choppy Sands range site.

Valentine fine sand, rolling (VaC) has layers similar to those described for the series. Slopes are 3 to 16 percent. In a few places the surface layer is loamy sand or loamy fine sand less than 6 inches thick.

This soil is closely associated with Valentine fine sand, hilly, and in places contains as much as 45 percent of that soil. Also included are small areas of Anselmo, Dunday, Elsmere, and Loup soils, in valleys, and areas of Valentine loamy sand, hummocky, that are not cultivated.

Nearly all this unit is in native pasture, but some is in trees. About 15,000 acres have been cultivated and should be reseeded to grass. This soil is more productive and more resistant to erosion than Valentine fine sand, hilly. Controlling grazing helps to maintain a good stand of native grass. Capability unit VIe–5; Sands range site.

Valentine loamy sand, hummocky (VcB) has layers similar to those described for the series, but the surface layer is lighter colored, thinner, or absent, and in most places it is loamy sand. Slopes are 3 to 8 percent. In some places the subsoil and substratum are both a loamy sand, and in many places a buried soil occurs. Severely eroded areas and blowouts too small to map separately are shown by symbols on the detailed soil map. This soil was mapped only in cultivated fields. Areas in pasture are included with Valentine fine sand, rolling.

Valentine loamy sand, hummocky, is low in productivity and highly susceptible to erosion if cultivated. The areas should be reseeded to adapted species of native grass. On this soil yields of forage are about equal to those on Valentine fine sand, rolling. Capability unit VIe–5; Sands range site.

Valentine soils and Rough broken land (VR) is an undifferentiated unit made up of Valentine soils and Rough broken land. The areas are along rivers on very steep, rough valley slopes. The soil material developed in mixtures of eolian sand and Ogallala sand, silt, and clay.

The Valentine soils of this mapping unit are similar to those mapped separately. Rough broken land is extremely variable. Slopes are generally more than 16 percent. The surface layer of Rough broken land is pale-brown fine sand or loamy sand 4 to 18 inches thick. It is underlain by a white substratum that is sandy loam in some places and heavy clay loam in others. In many places vertical banks of consolidated material of the Ogallala formation are exposed. Valentine soils make up 30 to 60 percent of this unit, and Rough broken land occupies 40 to 70 percent.

All of this mapping unit is in native grass. Capability unit VIIs–3; Thin Breaks range site.

Wann Series

The Wann series is made up of deep, dark, imperfectly drained soils. These soils are along the Middle and North Loup Rivers. Wann soils developed in alluvial sand and silt under dense, tall grass, where the supply of moisture was abundant and the water table was at a depth of 24 to 60 inches.

The surface layer is grayish-brown fine sandy loam. It ranges from 8 to 16 inches in thickness, but it averages between 10 and 12 inches and in places is weakly calcareous near the surface. Below the surface layer is a buried soil of dark-gray loam or silt loam 8 to 12 inches thick. This buried layer is calcareous and high in organic matter. It rests on gray fine sand that becomes lighter in color and coarser in texture with increasing depth.

Wann soils are among the most productive soils in the county. Yields of hay, pasture, and cultivated crops are high.

Wann fine sandy loam (Wb) is the only soil of the Wann series mapped in the county. It has layers similar to those described for the series. Slopes range from 1 to 3 percent.

About two-fifths of the acreage of this soil is cultivated, and the rest is used for hay and pasture. Irrigation improves yields of crops, and about 20 percent of the area is irrigated. Yields are normally among the highest in the county.

In many places blowing is a problem if the soil is left bare. Using stubble-mulch tillage or growing cover crops in winter helps to control soil blowing. Fertilizer should be applied in the kinds and amounts indicated by soil tests and field trials. Capability unit IIIw–6; Subirrigated range site.

Use and Management of Soils

This section discusses the use and management of soils in Thomas County for rangeland, for meadows, for cultivated crops, for woodland and windbreaks, for wildlife, and for engineering. It explains the practices of management appropriate for rangeland and describes the range sites in the county. Also, it explains the capability grouping used to classify soils for production of cultivated crops and predicts yields for the soils that are cultivated.

Managing Rangeland

More than 95 percent of all the land in Thomas County is in grass used for hay or pasture for livestock—the source of most income in the county. Most of the rest of the land produces supplemental feed for the livestock or is in ranch headquarters, roads, or other uses essential for ranching. Consequently, proper management of graz-

ing is important in obtaining the most economical production of livestock.

The purpose of this section is to help ranchers in planning the management of their range. It describes the range sites in the county, explains how range condition classes are appraised, provides estimated yields for range sites, and discusses practices that will improve yields from rangelands and native meadows.

Range sites

The rancher can best manage his soil and plant resources, for sustained high production, if he knows the soils and vegetation on his holdings. Soils differ in observable characteristics that are related to their ability to produce different kinds and amounts of native plants.

Soils that produce essentially the same kinds and amounts of climax vegetation are grouped into range sites. Each range site has its own combination of environmental conditions related to moisture, nutrients, and light. These ultimately can produce a characteristic plant community, termed *climax vegetation*, for the site.

Climax vegetation, representing the highest point of plant succession, is a relatively stable community compared to the weedy cover of old fields or to the condition of many ranges. It reproduces itself and changes little as long as climate and soil remain unchanged. It is the most productive combination of forage plants on rangeland, and a combination that will persist without tillage, fertilization, and replanting. Climax vegetation thus represents the potential in kind and amount of vegetation for a range site.

Surveys showing range sites and condition classes on a ranch give the operator an inventory of both present and potential grazing resources. They show areas of range that are producing below their potential and could be improved. They also show areas that are producing at their potential. Thus, by using surveys of range sites and condition classes, the rancher can plan a grazing program to improve or maintain his range.

Seven kinds of range sites are recognized in Thomas County. Burzlaff (*3*),[1] following research on three range sites in many sandhill counties of Nebraska, found that the silt-clay fraction of the sand soils correlated with differences in the vegetation when ranges in excellent condition were compared.

The soils in each of the seven sites in the county, the dominant forage plants in the climax vegetation of these sites, and percentages of total herbage each of these species may contribute are shown in table 2.

TABLE 2.—*Range sites of Thomas County and the soils in each, dominant plants in the climax vegetation, and the range in herbage production for each plant*

Range site and soils	Dominant plants	Range in percentage of total herbage on site
Sands:		
Valentine fine sand, rolling.	Prairie sandreed	20–50
Valentine loamy sand, hummocky.	Little bluestem	15–40
Blown-out land.	Sand bluestem	10–35
	Switchgrass	10–30
	Indiangrass	5–20
Choppy Sands:		
Valentine fine sand, hilly.	Little bluestem	25–60
	Sand bluestem	20–50
	Sand lovegrass	20–40
	Prairie sandreed	20–40
Sandy:		
Anselmo fine sandy loam.	Prairie sandreed	25–70
Anselmo fine sandy loam, hummocky.	Sand bluestem	15–50
Dunday loamy fine sand.	Switchgrass	15–50
Dunday loamy fine sand, hummocky.	Indiangrass	5–25
Dunday-Anselmo loamy fine sands, hummocky.	Needle-and-thread	5–20
Meadin-Dunday loamy fine sands.		
Meadin-Dunday loamy fine sands, hummocky.		
Hord complex, sandy variants.		
Subirrigated:		
Elsmere loamy fine sand.	Big bluestem	25–80
Loup loam.	Indiangrass	15–65
Wann fine sandy loam.	Switchgrass	20–75
Wet Land:		
Loup fine sand and Marsh.	Tall sedges	25–80
	Prairie cordgrass	20–75
	Reedgrasses	0–40
Shallow to Gravel:		
Gravelly land.	Blue grama and hairy grama.	20–60
Meadin loamy sand.	Sand dropseed	5–20
Thin Breaks:		
Valentine soils and Rough broken land.	Little bluestem	20–50
	Sand bluestem	10–40
	Side-oats grama	5–20

Range condition

Range condition is the present state of the vegetation as compared to climax vegetation for the kind of land (range site). It is expressed as a percentage, which shows how much of the present vegetation is of the same kind as that in the climax vegetation.

The deterioration or improvement of range condition is gradual. In the course of such changes the same area of land is successively occupied by many kinds of plants in many combinations.

The ranch operator should know the major kinds of range plants that should be growing on different sites. He needs to know how these plants respond to differences in grazing use, especially the appropriate time and intensity of use. He needs to know the condition of his range and whether it is deteriorating or improving.

All the food that plants use for growth is manufactured in their leaves. Removal of leaves during the manufacturing period affects growth of both roots and shoots. Livestock graze selectively, and they remove more leaves from some plants than from others. Their selection of plants for grazing varies with the season and the degree of use. For this reason, pastures respond to grazing in different ways. Some kinds of plants decrease, some increase, and others originally not present may invade.

[1] Italic numbers in parentheses refer to Literature Cited, p. 42.

These responses to grazing are used in a system for classifying range condition.

Decreaser species for a site are those present in the original community that decrease in amount of total herbage they contribute if they are closely grazed continuously during the growing season. *Increaser* plants are those of the original plant community that normally increase, at least for a time, in relative amount of total herbage they produce. They increase as decreaser plants cover less of the site. *Invader* plants are those not in the original plant community that begin growing in an area after the decreasers and increasers have been weakened or eliminated.

Range condition of an area is determined by comparing its present vegetation with the original or climax vegetation for the site. Four condition classes (*4*, *5*) are used to indicate this departure from the potential, or climax (fig. 8). These are *excellent*, *good*, *fair*, and *poor*. Comparison of vegetation along fence lines will be helpful in determining range condition (fig. 9).

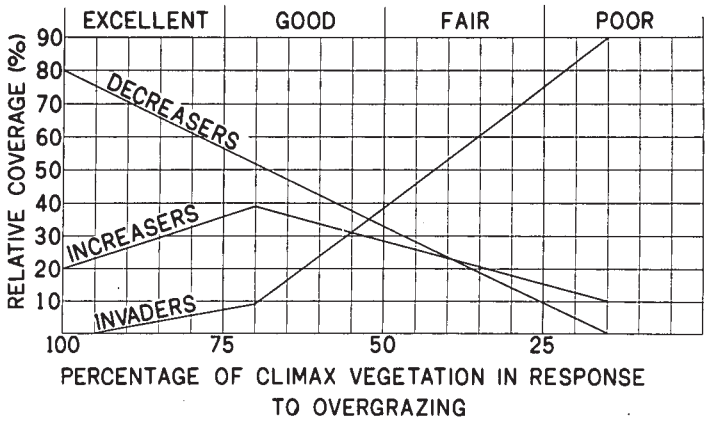

***Figure 8.*—Four range-condition classes based on percentage of climax vegetation and behavior of climax range plants under increasingly intensive grazing.**

***Figure 9.*—Range on left of fence is in fair condition; that on the right is in excellent condition. On the left tall grasses have been nearly eliminated, and yields have declined; short grasses now produce most of the forage, and annuals have invaded and they also have been grazed down.**

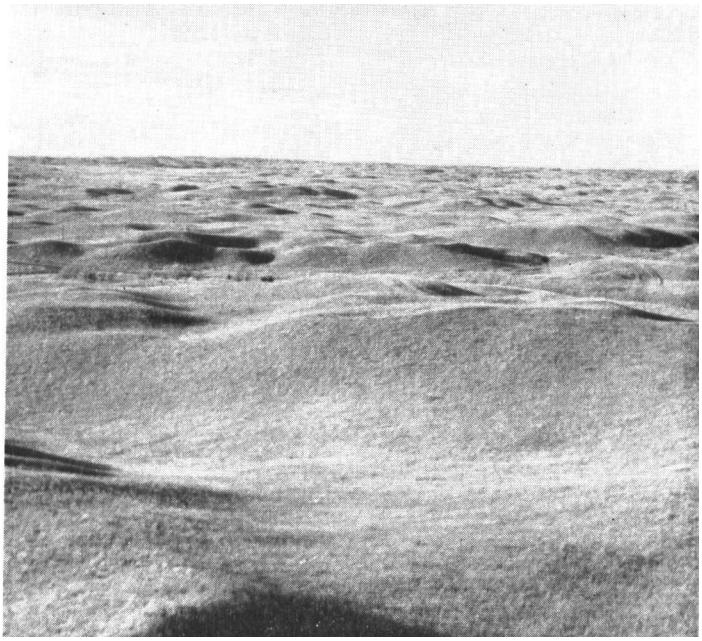

***Figure 10.*—Variation in relief of Sands range site. On this site tall and mid grasses produce abundant forage.**

The goal of range management is range in the excellent or good range-condition class. Greatest yields are obtained, on a sustained basis, if the range is in excellent condition. Also, if range is maintained in good to excellent condition, soil and water losses are reduced to a minimum because little rainfall and snowmelt are lost through runoff. Thus, the amount of moisture available in the soil for production of grass is increased.

Descriptions of range sites

Following are brief descriptions of the seven range sites recognized in Thomas County. Names of the soils included in each range site are given along with other distinctive features.

SANDS RANGE SITE

This range site is made up of deep, loose sand in nearly level areas and on rolling dunes (fig. 10). The soils in this site are well drained to excessively drained. They are—

Blown-out land.
Valentine fine sand, rolling.
Valentine loamy sand, hummocky.

Most areas are grazed, but some are mowed for hay or are grazed in winter. A few small areas have been cultivated, mostly along with finer textured soils. On the steeper slopes this range site merges with the Choppy Sands range site, and in the more nearly level areas it merges with the Sandy range site. In some places as much as 50 percent of this range site consists of small, irregular areas of soils of other sites, predominantly those of the Choppy Sands range site.

In excellent condition, this site supports good growth of tall and mid grasses. The principal grasses, in order of

abundance, are prairie sandreed, little bluestem, sand bluestem, and switchgrass. In areas that are overgrazed, sand bluestem and switchgrass decrease and prairie sandreed and little bluestem increase. If overgrazing continues, these grasses decrease and are replaced by needle-and-thread, sand dropseed, blue grama, and Scribner panicum. In areas that are severely overgrazed, perennial grasses are replaced by annuals and blowouts are likely to develop. The principal erosion hazard is from blowing where the soil has been bared by cattle trailing, by cattle concentrating, and by overgrazing.

Proper degree of use, deferred grazing, and uniform grazing are needed on this range site. Most areas that formerly were cultivated, and some other small areas, need reseeding. Control of blowouts is needed in some small areas.

If this site is used for hay, mowing practices that help to maintain or improve the condition of the range are needed.

CHOPPY SANDS RANGE SITE

Only one soil—Valentine fine sand, hilly—is in this range site. It is a deep, loose sand on very steep and high hills that have sharp peaks and ridges (fig. 11).

This site is used mainly for grazing. In most places blowing sand is evident on ridges exposed to wind. In a few places, generally on north slopes, there are small to large areas where native trees and shrubs are the dominant vegetation. The more level areas of this site merge with the Sands range site. In most places this site contains small, irregular areas of soils of other sites, mainly of the Sands site. In some places these areas make up as much as 45 percent of the total acreage.

In excellent condition this site supports a bunchy growth of tall and mid grasses. The principal grasses, in order of abundance, are little bluestem, sand bluestem, sand lovegrass, prairie sandreed, and switchgrass. In areas that are overgrazed, sand bluestem, sand lovegrass, and switchgrass decrease and prairie sandreed, little bluestem, sand dropseed, and hairy grama increase.

On this site practices that help control blowouts are needed along cattle trails, in areas where cattle concentrate, and in many other areas. Proper degree of use, deferred grazing, and uniform grazing help to maintain or improve the condition of the range. Because of loose sand, steep slopes, and exposed position, this site requires more care to prevent blowing than is needed for other range sites.

Figure 11.—Choppy Sands range site. The steep slopes and bunchy growth of grasses are typical of this site.

SANDY RANGE SITE

This range site is made up of deep or moderately deep, well-drained sandy soils. These soils are nearly level and are on floors of enclosed valleys or on terraces (fig. 12).

The soils in this site are—

Anselmo fine sandy loam.
Anselmo fine sandy loam, hummocky.
Dunday loamy fine sand.
Dunday loamy fine sand, hummocky.
Dunday-Anselmo loamy fine sands, hummocky.
Meadin-Dunday loamy fine sands.
Meadin-Dunday loamy fine sands, hummocky.
Hord complex, sandy variants.

Most of the land that formerly was cultivated is in this range site. About 30 percent of the acreage has been cultivated, and the areas need reseeding to restore the range to excellent condition. Suitable methods of seeding are discussed under "Range Seeding." On steeper slopes, where the texture of the soils is coarser, this range site merges with the Sands range site; at lower elevations, where the water table is near the surface, it merges with the Subirrigated range site. In places this site contains small, irregular areas of soils of the Sands or the Subirrigated range sites.

In excellent condition this site supports a dense stand of mid and tall grasses. The principal grasses, in order of abundance, are prairie sandreed, sand bluestem, switchgrass, and Indiangrass. In areas that are overgrazed, these grasses, and especially Indiangrass and sand bluestem, are replaced by blue grama.

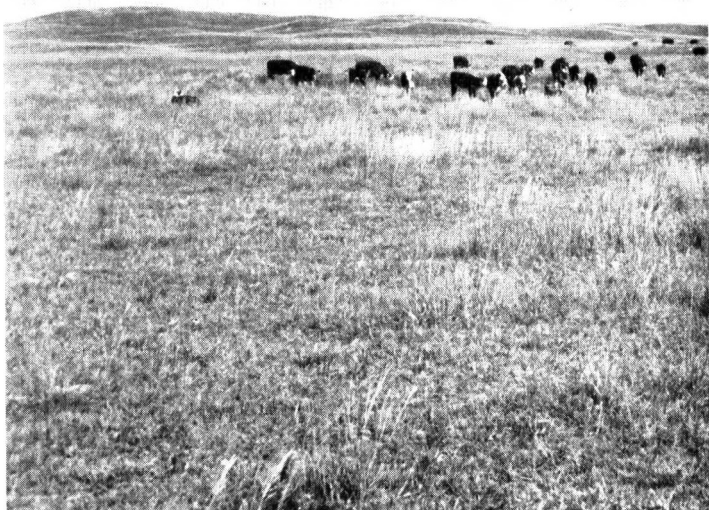

Figure 12.—Sandy range site showing typical nearly level to hummocky relief; soils shown are loamy fine sand and are firmer than the sandy soils on adjacent slopes.

Proper degree of use, deferred grazing, and uniform grazing are needed on this range site. Many areas that formerly were cultivated, and some overgrazed areas, need reseeding. Erosion is generally a hazard only if the ground is left bare.

If this site is used for hay, mowing practices that help maintain the condition of the range are needed.

SUBIRRIGATED RANGE SITE

In this range site are imperfectly drained and poorly drained soils on terraces or in enclosed upland valleys. The soils in this site range from loamy fine sand to loam. Slopes are nearly level to gentle and hummocky. The soils in this site are—

Elsmere loamy fine sand.
Loup loam.
Wann fine sandy loam.

The water table is at a depth of less than 5 feet in soils of this site, and it seldom rises above the surface of the soil during the growing season. Most areas are in native grass used for hay. Nevertheless, many small areas are in pasture and a few areas have been cultivated. At higher elevations this range site merges with the Sands or Sandy range site, and at lower elevations it merges with the Wet Land range site. In some places this site contains small areas of all of these range sites, but in a few places as much as 40 percent of this range site consists of soils of the Wet Land range site.

In excellent condition this range site has a dense stand of tall grasses. The principal grasses, in order of abundance, are big bluestem, switchgrass, and Indiangrass. As the condition of the range deteriorates, Kentucky bluegrass is the primary invader.

The hazard of erosion is not serious on the soils of this site unless the ground is left bare in a dry season. Some of the areas are in poor condition and need reseeding. Good management is needed to maintain or improve the condition of meadows.

WET LAND RANGE SITE

Only one mapping unit—Loup fine sand and Marsh—is in this range site. It is made up of poorly drained soils along rivers. The areas are nearly level to channeled.

This site is used mostly for hay because yields are high and the wet turf is easily damaged by trampling if grazed. The areas are under water during part of the growing season. At higher elevations areas of this site merge with the Subirrigated range site, and at lower elevations the areas merge with areas of Marsh. In some places small areas of Marsh and of the Subirrigated range site make up as much as 40 percent of the total acreage.

This site has a dense stand of tall sedges and grasses. The principal plants, in order of abundance, are tall sedges, prairie cordgrass, and reedgrasses. Erosion is not a hazard. Meadows on this site require management that maintains or improves their condition.

SHALLOW TO GRAVEL RANGE SITE

In this site are soils that are shallow over gravel. Slopes are nearly level to steep. The soils in this site are—

Gravelly land.
Meadin loamy sand.

These soils are droughty. The hazard of wind erosion is severe if the ground is left bare. Nearly all of this site is in native grass used for pasture. In some places this site contains small areas of soils of the Sands, the Subirrigated, and the Sandy range sites.

This site has a sparse stand of mid grasses and an understory of short grasses and drought-tolerant forbs. The principal grasses, in order of abundance, are blue grama, sand dropseed, and prairie sandreed.

Proper degree of use, deferred grazing, and uniform grazing are needed on this site to maintain or improve the condition of the range.

THIN BREAKS RANGE SITE

Only one mapping unit—Valentine soils and Rough broken land—is in this range site. It consists of deep, loose sands, shallow to deep sandy soils, and outcrops of Ogallala silt and sandstone along the sides of river valleys. Slopes are steep and the areas are dissected by a distinct drainage system.

This site is used for pasture. Deep sands make up 30 to 60 percent of the area, and steep sandy soils, 40 to 70 percent. Although Ogallala outcrops occupy very small areas, they are conspicuous because of their vertical banks.

Vegetation on this site is variable. Cedar, ash, and hackberry trees are commonly along the drainageways or above outcrops of fine-textured Ogallala material. Chokecherry, American plum, and other shrubs are generally in areas between the trees and grasses. On the shallow soils short grasses are dominant, and on the deep soils tall and mid grasses are dominant. The principal grasses, in order of abundance, are little bluestem, sand bluestem, prairie sandreed, and side-oats grama.

Proper degree of use, deferred grazing, and uniform grazing are needed on this site to maintain or improve the condition of the range. If the vegetation on this site is reduced or is destroyed, gullies occur along the drainageways and blowouts develop in sandy areas.

Herbage production

Listed below are the range sites of Thomas County and estimates of herbage production for the sites when in the excellent range-condition class. Two production figures are given for each site. These figures reflect anticipated range in annual yields between years that are favorable and those that are unfavorable for plant growth. The estimated herbage yields are air-dry weights, based on plot samples clipped level with the ground, here and in adjacent Sandhill counties through several years.

Range site:	*Range in pounds of herbage produced on range in excellent condition*
(1) Sands	1,500– 3,500
(2) Choppy Sands	1,000– 2,200
(3) Sandy	1,500– 3,500
(4) Subirrigated	3,500– 7,500
(5) Wet Land	5,500–11,000
(6) Shallow to Gravel	1,500– 2,500
(7) Thin Breaks	1,000– 2,200

These yields are estimates of potential yields. Each kind of range site produces successively less, in both favorable and unfavorable years, as range condition deteriorates through the good and fair to the poor condition class.

To maintain the yields listed, it is necessary to leave about one-half of the growth unused at the end of the growing season. Greater use than this is the primary cause of downward trend in range condition.

Principles of grazing management

There are four primary requirements that need to be met to practice range conservation through management of grazing:

(1) Proper degree of range use, considering the kinds of range plants to be encouraged in the pasture.
(2) Proper season of use, considering the need of the vegetation for improvement and the need of livestock for forage.
(3) Proper distribution of grazing throughout the pasture, so that, within practical limits, most of the pasture will be grazed to the proper degree.
(4) Proper kinds of livestock, considering the range sites and the kind of forage furnished by range plants.

PROPER DEGREE OF RANGE USE

Degree of range use refers to the amount of the current annual forage growth that is removed by grazing. This is important to the range manager because it affects the physiology of the plant, which in turn governs its production and ability to compete with the plants around it.

Proper range use is a degree of grazing use that will restore or maintain high range condition. For rapid improvement of range in poor condition, the proper range use would be none during the growing season.

The proper degree of range use on ranges in excellent condition is removal by grazing of about half the current year's growth (fig. 13). The growth left on the pasture forms a mulch that slows runoff and erosion and increases intake of moisture for growth the following year.

PROPER SEASON OF USE

The proper time to graze a given range site depends on the characteristics of the site, the range plants it supports, the growth periods of the principal plants, and the condition of the range. When to rest or graze a pasture to accomplish one of three purposes is illustrated in figure 14.

If range improvement is the main objective, it can be hastened by permitting the grass to grow unmolested for part or all of the growing season. Grazing can be withheld in spring, in fall, or for an entire growing season. The longer the rest period, the more rapidly the range improves toward excellent range condition. If no forage growth is removed, a mulch accumulates rapidly. This mulch brings more rapid improvement of the range because it creates a condition most favorable to the decreaser plants. The practice of not grazing range for a time during the growth period is called deferred grazing.

PROPER DISTRIBUTION OF GRAZING

If proper degree of range use is to be accomplished over an entire pasture, the distribution of grazing within the pasture requires planning. Livestock tend to gaze most in areas near water, where the relief is gentle, and near roads and trails. Distant corners and steep terrain are likely to be undergrazed.

Poor grazing distribution may be caused by too few watering places, or by locating salt, shade, and water all at one place. Concentration of livestock causes severe use in parts of a pasture. Too few watering places, or watering places that are poorly located, are the indirect cause of blowouts.

Watering places should be distributed in a way that will encourage livestock to graze a pasture uniformly. Salting locations should also be distributed. The salt should be placed in areas where grazing is to be encouraged and moved short distances, when necessary, to prevent local overuse and damage from trampling.

In many places it is practical to get better distribution of grazing by fencing different kinds of range sites into separate pastures. The Subirrigated range site, for example, has a very different kind and amount of forage than the Sands range site. A fence between these two sites is needed to achieve proper use and distribution of grazing.

KINDS OF LIVESTOCK

Cattle are best suited to graze the vegetation and range sites of Thomas County. A few ranchers raise some horses, but only a few sheep are grazed in the county.

Figure 13.—**Sandhill range late in August that is properly stocked. The cattle have ample forage, are making good gains, and will have taken half the current season's growth by the end of the grazing season.**

Range seeding

In many places in Thomas County, the vegetation on fields that formerly were cultivated or on areas where livestock concentrated consists mostly of weeds and weedy grasses. These areas produce little usable forage. Natural return to climax vegetation is slow. Many fields have not been cultivated for 20 to 30 years, and few if any plants of the climax vegetation are established on them.

Good stands of native grasses can be reestablished if a proper seedbed is prepared and the soil packed firmly around the seed, if competition from weeds is reduced, if the seedlings are protected from grazing until they are well established, and if erosion is controlled.

Dense stands of native grass can be obtained quickly, if erosion is not a serious hazard and if weeds are controlled, by growing intertilled crops for 1 or 2 years. Then a seedbed is prepared and a cover crop, preferably milo or sorghum, is planted. The following spring, be-

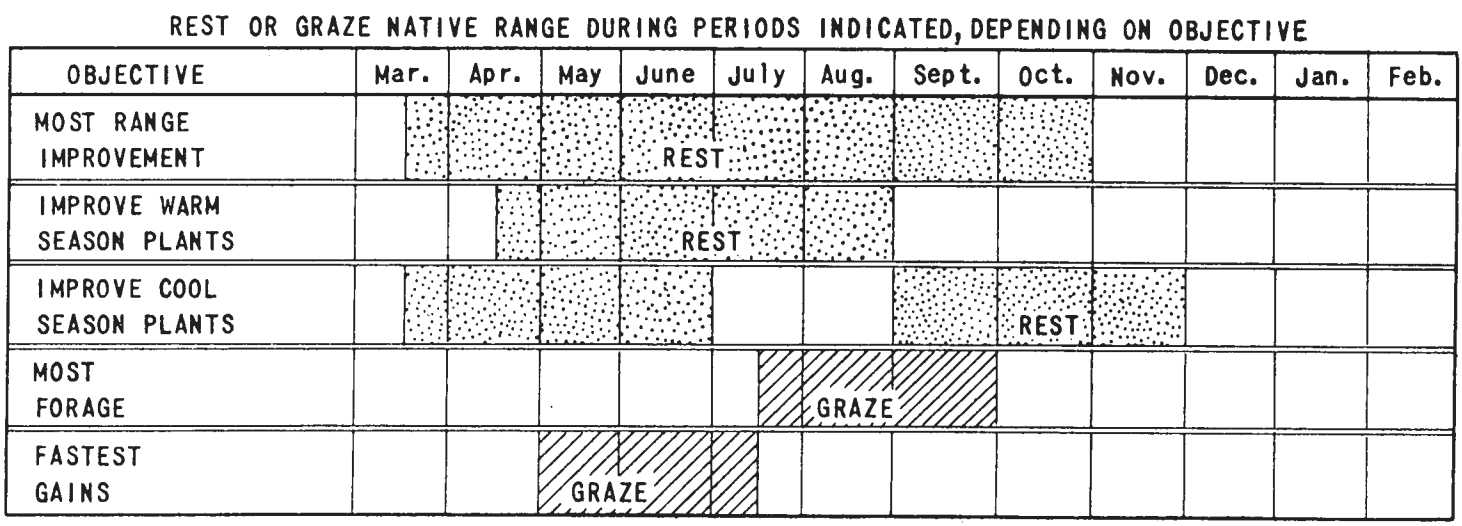

Figure 14.—Range improvement, maximum forage production, or fastest gains can be achieved through alternately grazing and resting pastures.

tween April 1 and May 15, an appropriate pasture mixture is seeded directly into the cover crop.

Native grass can be established on soils where the risk of erosion is high, or where there is a partial stand of desirable grass, by seeding with a range interseeder. This machine plants the seeds at the center of a broad, shallow furrow at the same time it clears the furrow. It also leaves an undisturbed area between the furrows that helps to control erosion. Seeding by this method is best done in April. Careful management is needed over a period of several years, so that the grass can spread into the areas between the planted rows.

In seeding native grasses on wet soils, thoroughly disk the land to reduce the weeds. Then, in August, drill a mixture of native grasses.

New seedings should not be grazed for 2 years after seeding. Grazing after that should be light, and preferably only in winter, until the stand reaches the density desired.

Managing Native Meadows

In Thomas County some areas are mowed annually for hay. These areas are mostly in the Subirrigated and the Wet Land range sites, and these sites cover only about 2,800 acres. Hay is also mowed from pastures that are to be grazed in winter and generally considered to be range. This hay is left on the pastures and little of it is stacked.

The native meadows produce from ½ to 2½ tons of hay per acre, depending on the range site and the condition of the plant cover. High yields are associated with high vigor of the plants, which is related to reserves of food in the plant roots. Most food reserves are stored in the roots as the plant nears maturity, and late mowing therefore helps to maintain high yields. However, late cut hay is lower in protein, phosphorus, and carotene than early cut hay. Because of the nutritional needs of livestock, mowing is done early and less forage results.

Most ranchers manage their meadows to perpetuate the stand and maintain yields. Where the acreage is large enough, dates of mowing are alternated between early and late on different parts of the meadows. The mowing is generally done early enough so that regrowth is good and seed stock ample. The regrowth is not mowed or grazed until after frost.

Response to the use of fertilizers on meadows varies widely. Although there is some response to nitrogen, it seldom is enough to make it practical to apply it. Phosphorus stimulates the growth of legumes and Kentucky bluegrass, and moderate to heavy applications have resulted in meadows that consist mostly of tame grass.

Because the acreage in meadow in the county is limited, most ranchers mow enough area, generally in the Sandy or Sands range sites, to provide winter feed. Yields are about one-half ton of hay per acre or less, depending on the condition of the range and amount of rainfall received. Most of this hay is bunched or baled and fed on the range.

Mowing affects the condition of the range in several ways. It leaves the land relatively bare, and therefore snow blows off readily. As a result, less moisture is available to plants in the season that follows, and yields are reduced. Skipping a strip 1 or 2 feet wide between swaths of the mower helps to catch and hold the snow. Mowing also removes much of the growth part of the taller grasses but removes only the leaves of the short grasses. Consequently, regrowth of the short grasses is faster than that of the tall grasses and the plants are more vigorous and more abundant.

Mowing on the Sandy and the Sands range sites should be done no oftener than once in 3 years. If the areas are mowed in one summer, they should not be grazed the next summer. They can nevertheless be safely grazed in fall or winter.

Control of Blowouts

There are more than 2,700 acres of Blown-out land in Thomas County, not including small blowouts shown only by spot symbols on the map. The blowouts are generally along trails or in places where livestock concentrate.

Blowouts produce little or no forage and are centers from which shifting sand blows and destroys more soil and vegetation. They can be revegetated and returned to productive pasture.

Small blowouts that have no vertical banks can be stabilized by fencing them to exclude livestock. Volunteer annuals and weedy plants generally stabilize the drifting sand in one or two seasons, and then native grasses gradually spread in from the edges. Revegetation can be hastened by mulching the areas with native hay that contains seed.

Large blowouts can be stabilized by fencing to exclude livestock, seeding sorghum, and mulching with hay. Banks should be smoothed to a 3 to 1 or flatter slope. Seed grass in early spring by drilling the seed into the cover left by the previous crop or by mulching with native hay containing seed. Stabilized blowouts can be grazed lightly and with caution.

Managing Cropland

Soils used for cultivated crops in Thomas County occupy less than 5,000 acres. Most of this acreage is used to produce supplemental pasture and feed for livestock in winter. The soils under cultivation are mostly sandy and moderately sandy and are of the Anselmo, Dunday, Elsmere, Hord, Meadin, Valentine, and Wann series.

Predicted yields

Predicted average yields of the principal crops on the soils of the county commonly cultivated are given in table 3. The yields are based on the best data available, but since many of the crops are grazed rather than harvested conventionally, recorded data are limited.

All of the cultivated soils are managed in about the same way. Approximately 60 percent of the cultivated acreage is in alfalfa, and the rest is in equal areas of corn and of rye or of rye and vetch. About one-fifth of the alfalfa is irrigated, but a small acreage of the other crops is irrigated. Recently ranchers have been converting cultivated areas to grass. This is done by permitting the areas to reseed naturally, or by direct seeding.

TABLE 3.—*Predicted average acre yields of the principal crops on the cultivated soils in Thomas County*

Soil	Corn	Rye	Rye and vetch	Alfalfa	
				Dry-land	Irri-gated
	Bu.	*Bu.*	*Tons*	*Tons*	*Tons*
Anselmo fine sandy loam	30	15	1. 2	1. 2	4. 0
Anselmo fine sandy loam, hummocky	25	12	1. 0	1. 0	3. 7
Dunday-Anselmo loamy fine sands, hummocky	20	10	. 8	. 8	3. 5
Dunday loamy fine sand	25	12	1. 0	1. 0	3. 7
Dunday loamy fine sand, hummocky	20	10	. 8	. 8	3. 5
Elsmere loamy fine sand	35	15	1. 2	1. 2	4. 0
Hord complex, sandy variants	30	15	1. 2	1. 2	4. 0
Meadin-Dunday loamy fine sands	20	10	. 8	. 8	3. 5
Valentine loamy sand, hummocky	10	10	. 5	. 5	3. 0
Wann fine sandy loam	40	15	1. 2	1. 2	4. 0

Dryland cropping practices

Corn, rye, vetch, and alfalfa are the main crops grown under dryland farming. Other crops have been grown but have not proved successful. Wheat does not yield well on the sandy soils, and sorghums fail to mature because of the cool nights. Spring-sown small grains are difficult to establish because of strong winds common during the planting season. Alfalfa is difficult to establish on dryland, and yields are low. The sandy surface of the soils dries out rapidly, and the alfalfa seedlings die from lack of water or are killed by blowing sand. Yields of alfalfa on dryland depend on rainfall and seldom are as much as 1½ tons.

Corn is planted with a lister with little or no ground preparation. This leaves the ground rough and protected from the wind at planting time. By the time the lister ridges have been worked down, the corn is tall enough to protect the soil from the wind. In the fall, rye, or a mixture of rye and vetch, is seeded between the corn rows to provide cover in winter. The corn is picked or is grazed along with the cover crop. If the rye looks good in the following spring, it is left and cut for hay or grain. If the prospects of a rye crop look poor in spring, the rye is pastured until corn-planting time, and the field is again planted to corn with a lister.

Irrigation practices

The main crop grown under irrigation is alfalfa, which is generally mixed with bromegrass. Phosphate fertilizer, and sometimes lime and sulfur, is needed to maintain high yields. Because of the low water-holding capacity of the sandy soils, the crop needs frequent light irrigations. When stands get thin, they are plowed up and the areas are reseeded. All irrigation is by sprinklers. Gravity irrigation is poorly suited because of the hummocks in most fields and because the rate of infiltration is too high for uniform irrigation. About 600 acres is irrigated from deep wells and from the Middle Loup River.

A large tree nursery of the Bessey Division of the Nebraska National Forest is irrigated. Here, seedlings are started and grown for forestry plantings.

Control of erosion

The soils of Thomas County are sandy and are especially susceptible to wind erosion. Water erosion is generally slight because the infiltration rate of the soils is high, and thus little water is lost through runoff.

The soils that are cultivated require protection from wind erosion to maintain productivity. In many fields that formerly were cultivated, the soils are no longer suitable for cultivation because of severe blowing. More than half the acreage in cultivation is class IV land, suitable only for occasional cultivation and needing special care that will prevent damage by erosion. Practices that help control wind erosion are growing crops in a suitable sequence, stripcropping, and proper use of crop residues.

A row crop should never follow a row crop in the cropping sequence. Plant rye and vetch for cover in the rows between the crops in fall and leave the cover crop for harvesting the following summer.

Stripcropping, the planting of row crops and close-sown crops in alternate strips, leaves strips of growing crops or crop residues to protect the soils from wind while new crops are being established in the alternate strips.

Cornstalks and stubble from other crops effectively protect the soils from wind if planted in strips at right angles to the prevailing winds. Grazing of these should be strictly controlled to avoid bare areas that will blow. The amount of crop residues produced can be increased by adding commercial fertilizer and growing soil-building legumes. Alfalfa, grasses, and similar close-growing crops protect the soil in all seasons.

Capability Groups of Soils

The capability classification is a grouping of soils that shows, in a general way, how suitable soils are for most kinds of farming. It is a practical grouping based on limitations of the soils, the risk of damage when they are used, and the way they respond to treatment.

In this system all the kinds of soil are grouped at three levels, the capability class, subclass, and unit. The eight capability classes in the broadest grouping are designated by Roman numerals I through VIII. In class I are the soils that have few limitations, the widest range of use, and the least risk of damage when they are used. The soils in the other classes have progressively greater natural limitations. In class VIII are soils and landforms so rough, shallow, or otherwise limited that they do not produce worthwhile yields of crops, forage, or wood products.

The subclasses indicate major kinds of limitations within the classes. Within most of the classes there can be up to four subclasses. The subclass is indicated by adding a small letter, *e*, *w*, *s*, or *c*, to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* means that water in or on the soil will interfere with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony, and *c*, used in only some parts of the country, indicates that the chief limitation is climate that is too cold or too dry.

In class I there are no subclasses, because the soils of this class have few or no limitations. Class V can contain, at the most, only subclasses *w*, *s*, and *c*, because the soils in it have little or no susceptibility to erosion but have other limitations that restrict their use largely to pasture, range, woodland, or wildlife.

Within the subclasses are the capability units, groups of soils enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity and other responses to management. Thus, the capability unit is a convenient grouping for making many statements about the management of soils. Capability units are generally identified by numbers assigned locally, for example, IIe–3 or IIIw–6.

Soils are classified in capability classes, subclasses, and units in accordance with the degree and kind of their permanent limitations, but without consideration of major and generally expensive landforming that would change the slope, depth, or other characteristics of the soils, and without consideration of possible but unlikely major reclamation projects.

The eight classes in the capability system, and the subclasses and capability units in Thomas County, are described in the list that follows.

Class I. Soils that have few limitations that restrict their use. (None in Thomas County.)

Class II. Soils that have some limitations that reduce the choice of plants or require moderate conservation practices.

- Subclass IIe. Soils subject to moderate erosion if they are not protected.
  - Unit IIe–3.—Nearly level to gently sloping, moderately sandy soils.

Class III. Soils that have severe limitations that reduce the choice of plants, or require special conservation practices, or both.

- Subclass IIIw. Soils that have severe limitations because of excess water.
  - Unit IIIw–6.—Moderately wet, moderately sandy soils on terraces.

Class IV. Soils that have very severe limitations that restrict the choice of plants, or that require very careful management, or both.

- Subclass IVe. Soils subject to very severe erosion if they are cultivated and not protected.
  - Unit IVe–3.—Gently rolling, moderately sandy soils.
  - Unit IVe–5.—Nearly level to gently rolling, sandy soils.
- Subclass IVw. Soils that have very severe limitations for cultivation, mainly because of excess water.
  - Unit IVw–5.—Nearly level, moderately wet, sandy soils on terraces.

Class V. Soils not likely to erode but that have other limitations, impractical to remove, that limit their use largely to pasture, woodland, or wildlife food and cover.

- Subclass Vw. Soils too wet for cultivation; drainage or protection not feasible.
  - Unit Vw–1.—Very wet, loamy soils on bottom lands; not flooded during the growing season.
  - Unit Vw–5.—Very wet, sandy soils on bottoms along rivers; flooded part of the growing season.

Class VI. Soils that have severe limitations that make them generally unsuited to cultivation and that limit their use largely to pasture, woodland, or wildlife food and cover.

- Subclass VIe. Soils subject to severe erosion if protective cover is not maintained.
  - Unit VIe–5.—Nearly level to rolling, very sandy soils.

Class VII. Soils that have very severe limitations that make them unsuitable for cultivation and that restrict their use largely to grazing, woodland, or wildlife.

- Subclass VIIe. Soils very severely limited by risk of erosion if protective cover is not maintained.
  - Unit VIIe–5.—Steep and very steep, deep, loose, very sandy soils.
- Subclass VIIs. Soils very severely limited by a shallow root zone or low fertility.
  - Unit VIIs–3.—Steep, sandy, and moderately sandy soils.
  - Unit VIIs–4.—Soils that are shallow over gravel.

Class VIII. Soils and landforms that have limitations that preclude their use for commercial production of plants and that restrict their use to recreation, wildlife, water supply, or to esthetic purposes.

Subclass VIIIw. Areas too unstable to utilize.

Unit VIIIw–1.—Areas that consist of the land type, Marsh; submerged most of the time.

Management by Capability Units

In the pages that follow, the capability units, or groups of soils similar in management requirements, are described; their limitations are given; and suitable management is discussed.

Capability unit IIe–3

The only soil in this unit is Anselmo fine sandy loam. It is a nearly level, moderately sandy soil of the uplands. This soil is easy to work. Wind erosion is a hazard if the soil is cultivated during the dry season.

This soil is suited to corn, rye, vetch, and alfalfa. It is the most productive upland soil in the county and also the most resistant to erosion. Soil-building crops are needed to maintain its fertility. If alfalfa is planted, it needs phosphate fertilizer and lime in amounts determined by soil tests. Yields of corn and rye increase in wet seasons if nitrogen fertilizer is added, but in dry seasons the response is likely to be poor.

This soil is suited to irrigation if it is protected from wind erosion. Sprinkler irrigation can be used without special land preparation. For gravity irrigation, land grading would be needed, and concrete ditches or gated pipe would conserve water.

Capability unit IIIw–6

The only soil in this unit is Wann fine sandy loam. It is a moderately wet, moderately sandy soil on terraces. This soil is deep. It is imperfectly drained because of seepage toward the rivers from the uplands. Nevertheless, it is the most productive soil for crops in the county.

This soil is suited to any of the crops commonly grown in the county. In dry years it is subject to blowing if it is left bare. The high water table generally is beneficial and increases yields, but in wet seasons it sometimes makes timely tillage difficult. Because the supply of water is favorable, crops on this soil should respond well to commercial fertilizer. The supply of water often is not sufficient for best yields of alfalfa without irrigation.

Capability unit IVe–3

The one soil of this unit is Anselmo fine sandy loam, hummocky, a gently rolling, moderately sandy soil.

Wind and water erosion are hazards on this soil. The short, irregular slopes make terracing or contour farming difficult. Yields are good if erosion is controlled.

This soil is suited to all crops commonly grown in the county. In many places where row crops have been grown, however, the soil is severely eroded.

A row crop should be grown no more often than once in 3 years on this soil. If commercial fertilizer is applied, yields increase, but generally the increase is limited to seasons when rainfall is favorable. Stripcropping reduces loss of the crop through blowing. A cover crop of rye and vetch, grown frequently, helps to maintain organic matter in the soil. Tillage that keeps crop residue on the surface and the growing of grasses and legumes, which do well on this soil, are practices that help control erosion.

Capability unit IVe–5

In this unit are nearly level to gently rolling, sandy soils. These soils absorb water rapidly and release it to plants readily. They are fairly productive but are susceptible to blowing. The soils are—

Dunday loamy fine sand.
Dunday loamy fine sand, hummocky.
Dunday-Anselmo loamy fine sands, hummocky.
Hord complex, sandy variants.
Meadin-Dunday loamy fine sands.
Meadin-Dunday loamy fine sands, hummocky.

The hazard of wind erosion is severe on these soils. Soil-building crops are needed to restore and to maintain fertility. Grazing of crops or of growth produced after cutting should be limited. If a row crop is grown, it should be followed by a winter cover crop, and the next year a close-sown crop should be grown. A suitable rotation would be corn, and then rye. The leaving of crop residues on the soils and the use of wind stripcropping help control wind erosion. Before alfalfa is seeded, the soils should be tested to determine the need for phosphate, sulfur, and lime.

Because these soils are undulating and low in water-holding capacity, they are poorly suited to irrigation. If they are irrigated, they must be protected from wind erosion.

Capability unit IVw–5

The only soil in this unit is Elsmere loamy fine sand. It is a nearly level, moderately wet, sandy soil on the terraces. The water table is high and generally benefits crops, but it may interfere with tillage in wet seasons. In dry seasons, the soil is subject to blowing.

This soil is suited to mixtures of alfalfa and grass. Yields are generally high because plenty of moisture is available from the high water table. Some other crops yield fairly well, but in dry seasons damage from blowing is likely to occur if the soil is cultivated and left unprotected.

Because of the favorable water supply, the soil should respond well to commercial fertilizer. Before alfalfa is seeded, the need for phosphate, sulfur, and lime should be determined by soil tests.

Capability unit Vw–1

The only soil of this unit is Loup loam, a very wet soil on river bottoms that are not flooded during the growing season. This soil is not suited to cultivation, because the water table is too near the surface most of the time.

This soil has a dense cover of tall grasses. Other than ordinary good management, no special practices are required for pasture or hay. Stocking and haying should be limited to maintain the vigor of the grasses. When this soil is wet, grazing should be controlled to avoid damage by trampling. Commercial fertilizer applied in field tests has not given consistent returns.

Capability unit Vw–5

The soils of this unit are mapped as one undifferentiated unit, Loup fine sand and Marsh. The areas are very wet.

They are on bottoms along rivers and the water table rises above the soil surface during part of the growing season.

These soils support dense stands of sedges, prairie cordgrass, reed canarygrass, reedgrasses, and other water-tolerant plants. Reed canarygrass has been introduced in some meadows and has increased yields.

Areas of these soils are too wet for cultivation and are best used for hay. In some years, however, high water makes haying difficult. Grazing should be limited to those times when the ground is frozen to avoid damage to the turf from trampling. Some of the areas can be improved by drainage ditches that remove excess water. Commercial fertilizer applied in field trials has not given consistent returns.

Capability unit VIe–5

This unit consists of nearly level to rolling, very sandy soils. The soils are well drained to excessively drained. They are—

Blown-out land.
Valentine fine sand, rolling.
Valentine loamy sand, hummocky.

Valentine fine sand, rolling, which is mostly in native grass, makes up about 71 percent of Thomas County. Some areas have been cultivated, and these should be reseeded to native grasses. Valentine loamy sand, hummocky, consists of less than a thousand acres—all of it being farmed. Areas of Blown-out land that are in range should be protected from blowing and reseeded to native grasses. Methods of stabilizing blowouts are discussed under the heading "Control of Blowouts."

None of these soils are suited to cultivation, but they make excellent range if kept in native grass and properly managed.

Capability unit VIIe–5

The only soil of this unit, Valentine fine sand, hilly, is a deep, loose, very sandy soil on steep and very steep dunes. The soil is poorly stabilized and is low in organic matter.

This soil is too sandy and steep for cultivation. Stands of grass are good, however, if the soil is properly managed for control of erosion. If grazing is controlled, yields of forage are good.

Capability unit VIIs–3

The soils of this unit are mapped as one soil complex, Valentine soils and Rough broken land. The Valentine soils are deep, loose sands; Rough broken land is shallow to deep, moderately sandy, and on rough broken slopes. Outcrops of soft Ogallala sandstone occur in many places.

This complex is too sandy and steep, and the areas are too rough, for cultivation. It produces a fair crop of native grass when properly managed. Grazing must be carefully controlled to prevent erosion.

Capability unit VIIs–4

This unit consists of soils that are shallow over gravel. These soils are on terraces and slopes of river valleys. They are—

Gravelly land.
Meadin loamy sand.

The water-holding capacity of these soils is too low for profitable tillage. The soils produce fair yields of short grasses if grazing is controlled to prevent killing out the native grasses. Revegetation is extremely difficult.

Capability unit VIIIw–1

This unit consists of the land type, Marsh, the areas of which are submerged most of the time. The water is shallow, and many plants grow on the areas.

Cattails, rushes, and similar water-tolerant plants make up much of the vegetation on this land type. In some places willows and indigobush amorpha are abundant. Marsh makes good habitats for wildlife. Some areas have been drained, and these are managed the same as soils in capability unit Vw–1 or Vw–5.

Woodland and Windbreaks[2]

The few native trees that grow in Thomas County are chiefly along the Dismal and Middle Loup Rivers and their tributaries. Since settlement, the spread of native trees to other parts of the county has been encouraged through control of prairie fires.

The native trees of this county have little commercial value other than for the few fence posts or small poles they provide. The kinds of trees that grow depend somewhat upon the location.

Scattered black willows, diamond willows, sandbar willows, cottonwoods, and boxelders grow in the low wet areas along streams. On the drier, steep sites in the river breaks are redcedar, green ash, hackberry, American elm, and boxelder.

Among the native shrubs that grow in sheltered areas where moisture conditions are favorable are black currant, golden currant, gooseberry, coralberry, Bessey cherry, American plum, western chokecherry, skunkbush sumac, buffaloberry, elderberry, dogwood, raspberry, leadplant, and indigobush.

Since establishment of the Nebraska National Forest, fairly large stands of Jack pine, ponderosa pine, Austrian pine, and redcedar have been successfully grown, and also, a few small stands of Scotch pine and red pine (fig. 15). Posts and poles have been harvested from some stands when the stands were thinned, particularly in plantations of Jack pine.

Planting windbreaks.—Windbreaks have been planted for the protection of ranch headquarters ever since settlement of the county. The need for windbreaks for winter protection for livestock has long been recognized. Successful plantings of trees in the Nebraska National Forest have greatly encouraged the planting of redcedar and pine to protect ranch headquarters and livestock in winter (fig. 16). The soils in the greater part of the county are sandy, and preparation of a site for tree planting in most places consists of opening a shallow furrow in the sod and placing the young trees in the furrow.

Cultivation of the trees after planting is not feasible on the sandy soils. Therefore, only redcedar, Rocky Mountain juniper, ponderosa pine, Austrian pine, and similar conifers are suited. These trees withstand the competition of native grasses fairly well. Broadleaf species, on the other hand, must receive clean cultivation to survive. In wet areas and in subirrigated areas cottonwoods, willows, and other broadleaf trees that tolerate wetness can be planted. If the areas are not too wet, the site

[2] By SIDNEY S. BURTON, woodland conservationist, Soil Conservation Service.

Figure 15.—Part of an area in the Bessey Division of the Nebraska National Forest that has been planted to trees.

Figure 16.—Ranch headquarters well protected by trees planted for windbreaks.

can be prepared by plowing and disking a 4- to 6-foot strip for each row of trees. Strips of sod left between the cultivated strips minimize soil blowing. If wetness prevents clean cultivation, the site can be prepared by stripping the sod and planting the trees in the shallow furrow.

Windbreaks planted for winter protection of livestock are best if they are wide enough to hold all the drifting snow within the tree belt. Normally, this requires a minimum of 10 rows of trees. The windbreak should be long enough to keep cattle from concentrating in a small area and trampling the grass.

Redcedar should be planted in the windward half of the windbreak at 4- to 6-foot intervals to make a good tight barrier. Pine trees, planted 8 to 10 feet apart in the rest of the barrier, add height to the barrier. After the pine trees are 12 to 15 feet tall, livestock can be allowed to seek shelter under the trees during storms without serious damage to the trees.

The soils of Thomas County have been placed in windbreak suitability groups based on their suitability for similar kinds of trees. These groups, the soils in each, and the kinds of trees suitable for planting on soils of each group are shown in table 4.

TABLE 4.—*Windbreak suitability groups and kinds of trees suitable for planting*

Site descriptions	Kinds of trees suitable for planting			Remarks
	Shrubs	Conifers	Broadleaf trees	
Sandy site. Slightly sandy soils and nearly level, very sandy soils. Anselmo fine sandy loam. Anselmo fine sandy loam, hummocky. Dunday-Anselmo loamy fine sands, hummocky. Dunday loamy fine sand. Hord complex, sandy variants. Meadin-Dunday loamy fine sands.	American plum, Western sandcherry, threeleaved sumac, honeysuckle.	Redcedar, Rocky Mountain juniper, ponderosa pine, Austrian pine.	Boxelder, green ash, honeylocust, Siberian (Chinese) elm, cottonwood.	Good soils for planting trees if soil blowing is prevented by cultivating only in tree rows and strips of vegetation are left between the rows.
Very sandy site. Very sandy soils and loose sands that cannot be safely cultivated. Blown-out land. Dunday loamy fine sand, hummocky. Meadin loamy sand. Meadin-Dunday loamy fine sands, hummocky. Valentine fine sand, rolling. Valentine fine sand, hilly. Valentine loamy sand, hummocky. Valentine soils and Rough broken land.	None.	Redcedar, ponderosa pine.	None.	Only conifers can be successfully grown on this site; they should be planted in a shallow furrow and should not be cultivated.
Moderately wet site. Soils of bottom lands and upland valleys that are wet some of the time because of a high water table or frequent flooding for a short time. Elsmere loamy fine sand. Wann fine sandy loam.	Purple willow, red osier dogwood, chokecherry, buffaloberry.	Redcedar, Scotch pine.	Diamond willow, golden willow, white willow, boxelder, green ash, honeylocust, Russian olive, cottonwood.	Good soils for planting trees if trees and shrubs are selected that tolerate occassional wetness.
Wet site. Soils of bottom lands and upland depressions that are wet most of the time because of flooding, high water table, or poor drainage. Loup fine sand and Marsh. Loup loam. Marsh.	Purple willow, red osier dogwood.	None.	Diamond willow, laurelleaf willow, golden willow, white willow, cottonwood, silverleaf poplar.	Only those trees that tolerate wetness are suitable for planting on soils of this site.

Management of Bessey Division, Nebraska National Forest[3]

The Bessey Division of the Nebraska National Forest contains 79,844 acres. Of this acreage, 22,180 acres is in trees and the rest provides summer range for livestock.

Two soils are predominant in the Bessey Division. These are Valentine fine sand, rolling and Valentine fine sand, hilly. A small acreage of Dunday soils occupies depressional areas and Meadin and Dunday loamy fine sands make up the acreage in the forest tree nursery. The soils occur in association with each other and are predominantly coarse textured. They are very susceptible to erosion by wind if the vegetation on them is destroyed. The infiltration rate of the soils is high, and the soils are very permeable. Little runoff occurs, however, and water erosion is not a problem. The water-holding capacity of the soils is low, but rainfall, even from light showers, readily enters the soils and is therefore available for plant growth.

Trees grow better on the rolling Valentine soil than on the hilly Valentine soil because moisture relations are better and exposure to wind is less. Best growth is on the lower slopes of the rolling Valentine soil in some of the

[3] By CHARLES FOX, soil scientist, U.S. Forest Service.

valleys. The soils throughout the planted areas are quite uniform, and no other differences in timber growth can be attributed to differences between the soils.

The first trees were established in the forest in 1903, when 70,000 jack pine and ponderosa pine seedlings were planted. The main kinds of trees now in the area and the acreages of each are as follows:

	Acres
Ponderosa pine	7,319
Jack pine	3,416
Eastern redcedar	2,550
Scotch, red, and Austrian pines	265

The stands of ponderosa pine range in age from 12 to 50 years. Ponderosa pine is a slow-growing tree for the first few years, but it makes excellent growth thereafter.

Most of the jack pine stands range from 20 to 50 years in age. Because its shallow root system does not penetrate to available water, jack pine does not do well during years of drought. Many trees 5 to 10 years of age or older have died. Jack pine has good form, grows to good height, and is suitable for posts and small poles. In this area the life of jack pine seems to be 40 to 50 years.

Eastern redcedar grows rapidly, withstands severe drought, and is resistant to insects and diseases.

Small plantations of Scotch, Austrian, and red pines are scattered throughout the timbered area. The trees in these stands have made fair to good growth and have fairly good form, but many of the Scotch pines have died and others are dying.

Future planting of all species will be restricted to the more favorable sites on north and east slopes. Stands of mixed species show promise of better form and quality than stands of a single species. Past records indicate an average annual growth of approximately 60 cubic feet per acre per year in this area. By restricting future stands to the more favorable sites, both yield and quality can be upgraded.

Reforestation is practiced in the area. Plantings generally have been successful and reforestation will need to continue, unless ways are found to establish natural regeneration. Cutover areas need to be replanted if trees do not regenerate naturally within 3 years after a cutting.

Pine tip moths, *Rhyacionia frustrana* and *R. neomexicana*, are found throughout all stands of ponderosa pines. These moths were first observed in the area in 1909. Parasite control was tried but was not too successful. The pine tip moth causes undesirable changes in the form of the ponderosa pine.

Forest tree nursery.—The National Forest area includes the Bessey Nursery, near Halsey. It contains about 40 acres in seed and transplant beds. The annual output of the nursery is about 6 million trees, mainly transplants of 2- and 3-year-old pines and Eastern and Rocky Mountain redcedars. Production of juniper and hardwood seedlings is excellent, but production of spruce and lodgepole pine seedlings is marginal.

The soils in the nursery are a mixture of Meadin and Dunday loamy fine sands. These soils are alluvial in origin and have been considerably altered by leveling, irrigation, and soil management. Although the nursery is productive, a number of management problems are related to the soils.

The soils consist of about 98 percent fine sand. They are very low in moisture-holding capacity, and plant nutrients are quickly leached from them. The content of organic matter is low. Seedlings are frequently lost because of damping-off fungi. Because of irrigation, the pH values of the soils are between 6.8 and 7.2, which is higher than is desirable for a nursery. Sulphuric acid is used to lower the pH. Plant nutrients are supplied through frequent, light applications of liquid fertilizer. Peat, added every year, supplies organic matter and improves tilth of the soils.

Forage in the forest.—The forage in all parts of the forest is grazed, except where grazing would interfere with tree planting. When the trees in plantations in the forest are large enough that rubbing by cattle does not materially injure them, grazing is permitted in the plantation. Grazing provides summer range for cattle on nearby ranches and also reduces danger of fire.

Herbage on range in the forest is dominated by tall prairie grasses, but in places mid grasses are common and some short grasses are present.

On the rolling Valentine soil, which occupies the less steep, more smoothly rounded sandy ridges, little bluestem is dominant, but sand lovegrass predominates in places. Other forage plants here are sand bluestem, prairie sandreed (*Calamovilfa longifolia*), and switchgrass. Yucca and pricklypear grow in a few places.

The hilly Valentine soil occupies the more irregular, choppy areas where the slope is steeper. A characteristic feature of this soil is the series of benches on the slopes resembling "catsteps." The cover of vegetation on the hilly Valentine soil is more sparse than on the rolling Valentine soil. It consists of little bluestem, sand bluestem, prairie sandreed, sand lovegrass, and switchgrass. Little bluestem predominates, but the proportion of prairie sandreed is greater than on the rolling Valentine soil. Yucca, in particular, and pricklypear are also more common. Also, the water-holding capacity is lower than in the rolling Valentine soil. Consequently, the proportion of drought-resistant plants is greater.

Dunday soils, in well-drained depressions, basins, or enclosed valleys, are higher in organic matter than the Valentine soils and have a higher proportion of fine material. The proportion of blue grama in range on Dunday soils is higher than on Valentine soils. Also, Dunday soils are less susceptible to wind erosion than the Valentine soils and therefore provide good sites for windmills. The acreage of Dunday soils in the Bessey Division is small, however.

The forest is in the Sandhills region of Nebraska, which is well suited to grazing by cattle. The summer grazing season extends from May 16 to November 30. If the range is in good condition, tall prairie grasses are abundant, but as the condition of the range decreases mid grasses and short grasses increase.

In the forest the grazing capacity of range in good condition is about 2 acres per animal-unit month. On range in fair condition, the grazing capacity is about 4 acres per animal-unit month. The carrying capacity of the hilly Valentine soil is about half that of the rolling Valentine soil. The soils generally occur in a complex pattern and are used and managed together. The soil survey maps at the back of the report show which soil is dominant in an area and stocking can be adjusted accordingly. The range should be stocked and managed to produce the maximum of high-quality forage on a sustained yield basis without damage to the soil through overgrazing.

Blowouts, caused by cattle milling about water tanks around windmills, are a problem. Placing salt and back scratchers for the cattle away from water tanks reduces the intensity of use and thus helps reduce erosion and blowouts. Providing additional wells and alternating their use with existing wells so that some areas can be rested at regular intervals also help control erosion. In addition, the use of soil cement or other soil stabilizers on areas that are used intensively should be investigated. Blowouts are common along firebreaks in the forest. If hay is scattered over these areas to help stabilize them, they revegetate in a short time.

Although the soils in the forested area are sandy, wind erosion is not severe except in local areas where the soils are put to intense use. If good management is used, however, erosion can be prevented in most areas. Grazing of the range must be carefully controlled. Overgrazing results in erosion, and if a blowout starts in eroded areas, it is difficult to heal. Practices based on the grazing capacity of the site, proper distribution of cattle through placement of water and salt, and other good management are needed for the control of erosion.

Wildlife[4]

The kinds and amounts of wildlife that can be produced and maintained in the county are largely determined by the kinds and amounts of vegetation that the soils can produce and by the way the vegetation is distributed.

Wildlife is influenced by topography and by such soil characteristics as fertility. Fertile soils are capable of greater wildlife production than less fertile soils, and waters that drain from fertile soils generally will produce more fish than waters that drain from infertile soils. Topography affects wildlife through its influence on land use. Extremely rough, irregular areas may present hazards to livestock, and the undisturbed vegetation in such areas is often valuable to wildlife. If suitable vegetation is lacking in such areas, it can often be developed to improve conditions for desirable kinds of wildlife.

Wetness and water-holding capacity of the soils are important in selecting sites for construction of ponds for fish and in developing and maintaining habitats for waterfowl. Swampy and marshy areas lend themselves to development of aquatic and semiaquatic habitats of value to waterfowl and to some furbearers.

The soils of Thomas County produce suitable habitats for a number of wildlife species. Some species, such as elk, buffalo, and wolves, are no longer found in the county. Others, particularly deer and sharptail grouse, are still present. Antelope and wild turkey have been reintroduced. Among the small animals in the county are raccoon, opossum, weasel, mink, muskrat, coyote, skunk, rabbits, and rodents.

Many kinds of birds live in the county throughout the year. Waterfowl are found primarily along the valleys of the Dismal and Loup Rivers. Birds that like a woody habitat are also found along these streams and in farmstead and livestock windbreaks. A few prairie chickens are in areas where soils permit the kind of land use that provides a suitable habitat.

[4] By CHARLES BOHART, biologist, Soil Conservation Service.

Channel catfish are common in the Dismal, Middle Loup, and North Loup Rivers. Sites suitable for developing ponds for production of fish are limited to areas in these valleys. In some places the streams could be improved for fish.

The wildlife resources of the county are important primarily for the recreational opportunities they provide. Many species of wildlife are also beneficial in control of rodents and undesirable insects.

The combination of soils, topography, and vegetation in the county provides opportunities for developing facilities for recreation. Opportunities for combining recreational enterprises with ranch operations could be explored. Many people are interested in typical ranch operations and would like the opportunity to learn about and take part in normal activities on a ranch. Such an enterprise would be especially valuable to ranchers whose opportunities are limited by the size of their ranch.

Increased travel by the American public also provides opportunities for using suitable soils for recreational purposes. Some areas along main highways through the county are suitable as sites for overnight camping facilities, which would be a real convenience to travelers and a source of supplemental income for landowners.

Recreation oriented toward the fish and wildlife resources in the county would be primarily based on hunting and fishing. Nevertheless, many people enjoy wildlife for itself and would appreciate it if areas were provided where wildlife could be seen, heard, and photographed. If production of fish and wildlife for recreation is considered, the kind of soils in an area will be an important factor in the success of the enterprise.

The potential of the soil associations in Thomas County for producing habitats for the more important species of wildlife is given in table 5. The ratings of very good, good, and fair in the table take into account the kinds of soils in each association and their potential (shown in the column titled "Food") for producing the kind of vegetation needed for the various habitats. For more detailed information about the soil associations refer to the section "General Soil Map," and then turn to the "Descriptions of the Soils" for further information about each soil.

Engineering Properties of the Soils[5]

Some properties of soils are of special interest to engineers because they affect construction and maintenance of highways, airports, pipelines, foundations, and facilities for storing water, controlling erosion, irrigating and draining soils, and disposing of sewage. The properties most important to the engineer are texture, permeability, shear strength, plasticity, moisture-density relationships, compressibility, workability, and water-holding capacity. Topography and depth to water table, to bedrock, or to sand and gravel are also important.

[5] By HERBERT B. AUCH MOEDY, area engineer, MERRITT A. PLANTZ, soil scientist, with the assistance of LEE E. SMEDLEY, engineer, all of Soil Conservation Service, and WILLIAM J. RAMSEY, geologist, Division of Materials and Tests, Nebraska Department of Roads. The work by the Department of Roads was performed under a cooperative agreement with the U.S. Department of Commerce, Bureau of Public Roads.

TABLE 5.—*Potential of soil associations for producing habitats for more important wildlife* [1]

Soil association	Wildlife	Potential for producing, for species of wildlife named—			
		Woody cover	Herbaceous cover	Food	Aquatic environment
Valentine, rolling.	Sharptail grouse	Good	Very good	Good	
	Prairie chicken	Good	Very good	Fair	
	Deer	Good	Very good	Fair	
	Antelope		Good	Fair	
Valentine, rolling-Anselmo.	Sharptail grouse	Good	Very good	Good	
	Prairie chicken	Good	Very good	Good	
	Antelope		Good	Fair	
	Deer	Good	Very good	Fair	
Valentine, hilly.	Sharptail grouse	Good	Very good	Very good	
	Deer	Good	Very good	Good	
	Waterfowl				Fair.
	Turkey	Fair	Fair	Fair	
Valentine, hilly–Dunday.	Sharptail grouse	Fair	Very good	Fair	
	Antelope		Good	Good	
	Prairie chicken	Good	Very good	Good	
	Pheasant	Fair	Good	Fair	
	Deer	Good	Very good	Fair	
Dunday-Loup.	Sharptail grouse	Very good	Fair	Good	
	Prairie chicken	Very good	Fair	Very good	
	Deer	Very good	Very good	Very good	
	Turkey	Fair	Fair	Fair	
	Furbearers	Good	Good	Good	
	Waterfowl				Fair.
	Fish				Good.
	Pheasant	Good	Good	Fair	

[1] Development of specific habitats for wildlife requires proper location and distribution of the kind of vegetation that the soils can produce. Technical assistance in planning wildlife developments and determining the species of vegetation to use can be obtained at the District Office of the Soil Conservation Service. Additional information and assistance can be obtained from the Nebraska Game, Forestation and Parks Commission, Bureau of Sport Fisheries and Wildlife, and from the Agricultural Extension Service.

Information in this report can be used to—

1. Make soil and land use studies that will aid in selecting and developing sites for industrial, business, residential, and recreational use.
2. Make preliminary estimates of the engineering properties of soils for use in the planning and designing of structures and of measures for the conservation of soil and water.
3. Make preliminary evaluations of soil and ground conditions that will help in selecting locations for highways and airports and in planning detailed investigations at the selected locations.
4. Estimate drainage areas and runoff characteristics for use in the design of culverts and bridges.
5. Classify soils along a proposed highway route for use in making preliminary estimates of the required thickness for flexible pavement.
6. Estimate the need for clay to stabilize the surfacing on roads that are not paved.
7. Locate deposits of sand, gravel, rock, mineral filler, and soil binder for use in constructing sub-base courses, base courses, and surface courses for flexible pavements for highways and structures.
8. Make preliminary evaluations of terrain, such as topography, surface drainage, subsurface drainage and height of water table, that need to be considered in designing highway embankments, subgrades, and pavements.
9. Correlate performance of engineering measures and structures with soil mapping units, and thus develop information that will be useful in designing and maintaining these measures and structures.
10. Determine the suitability of soils for the cross-country movement of vehicles and construction equipment.
11. Supplement the information obtained from other published maps, reports, and aerial photographs to make maps and reports that can be readily used by engineers.
12. Develop other preliminary estimates for construction purposes pertinent to the particular area.

It is not intended that this report will eliminate the need for on-site sampling and testing of the soils for design and construction of specific engineering works. The interpretations in the report should be used primarily in planning more detailed field investigations to determine the in-place condition of the soil at the proposed site for engineering works.

Some of the terms used by the soil scientist may be unfamiliar to the engineer, and some words, for example, soil, clay, silt, sand, and aggregate, have special meaning in soil science. Most of these terms, as well as other special terms used in the soil survey report, are defined in the Glossary.

To make the best use of the soil maps and the soil survey reports, the engineer should know the physical properties of the soil materials and the in-place condition of the soil. After testing the soil materials and observing the behavior of each soil when used in engineering structures and foundations, the engineer can develop recommendations for each soil unit delineated on the map.

Engineering classification systems

Two systems of classifying soils are in general use among engineers. Both are used in this report. It is assumed that any persons using this report will be familiar with these systems or will have available reference material on these two classification systems.

Most highway engineers classify soil materials in accordance with the system approved by the American Association of State Highway Officials (AASHO) (*1*). In this system, soil materials are classified in seven principal groups. The groups range from A–1, consisting of gravelly soils of high bearing capacity, to A–7, which is made up of clay soils having low strength when wet. Within each group, the relative engineering value of the material is indicated by a group index number. The group index for the soil groups A–1, A–2, and A–3 is 0, except that the poorest soils in group A–2 have a group index of 4. For the poorest soils in group A–4, the group index is 8; in group A–5 the poorest soils have a group index of 12; and in group A–6 the poorest soils have a group index of 16; in A–7 the poorest soils have a group index of 20. In table 6, the group index number is shown in parentheses after the soil group symbol.

Some engineers prefer to use the Unified Soil Classification System (*7*). This system is based on identification of soils according to their texture and plasticity, and the soils are grouped according to their performance as engineering construction materials. The system establishes 15 soil groups. The soil materials are identified as coarse-grained soils (eight classes), fine-grained soil (six

TABLE 6.—*Engineering test data on samples taken*

Soil name and location	Parent material	Nebraska report No.	Depth	Horizon	Moisture-density [2]	
					Maximum dry density	Optimum moisture
			Inches		*Lb. per cu. ft.*	*Percent*
Anselmo fine sandy loam:						
0.35 mile E. and 0.1 mile S. of NW cor. of sec. 28, T. 24 N., R. 26 W.	Eolian silt and sand.	S 62–3186	0–7	Ap	109	13
		S 62–3187	9–34	AC	112	14
		S 62–3188	34–72	C	113	13
Dunday loamy fine sand:						
0.15 mile N. and 0.1 mile W. of SE cor. of sec. 16, T. 24 N., R. 29 W.	Eolian sand.	S 62–3178	0–7	Ap	111	12
		S 62–3179	9–32	AC	112	12
		S 62–3180	32–72	C	111	12
Elsmere loamy fine sand:						
0.2 mile N. of center sec. 11, T. 23 N., R. 28 W.	Alluvial sand.	S 62–3181	0–8	Al	106	14
		S 62–3182	8–24	AC	113	12
		S 62–3183	24–72	C	107	14
Meadin loamy sand: [6]						
0.3 mile N. and 300 feet E. of SW cor. of sec. 1, T. 22 N., R. 26 W.	Alluvial sand and gravel.	S 62–3184	0–5	Al	113	12
		S 62–3185	18–72	C	111	9
Valentine fine sand, rolling:						
0.15 mile W. and 0.3 mile N. of SE cor. of sec. 22, T. 24 N., R. 28 W.	Eolian sand.	S 62–3176	7–20	AC	109	12
		S 62–3177	20–72	C	108	14
Valentine fine sand, hilly:						
0.2 mile S. and 0.25 mile W. of center sec. 3, T. 21 N., R. 28 W.	Eolian sand.	S 62–3175	5–72	C	107	14

[1] Tests performed by the Nebraska Department of Roads in cooperation with U.S. Department of Commerce, Bureau of Public Roads, in accordance with standard procedures of the American Association of State Highway Officials (AASHO) (*1*).

[2] Based on AASHO Designation T 99–57, Methods A and C (*1*).

[3] Mechanical analyses according to the AASHO Designation: T 88–57 (*1*). Results by this procedure frequently may differ somewhat from results that would have been obtained by the soil survey procedure of the Soil Conservation Service (SCS). In the AASHO procedure the fine material is analyzed by the hydrometer method, and the various grain-size fractions are calculated on the basis of all the material, including that coarser than 2 millimeters in diameter.

classes), and highly organic (one class). Boundary classifications are provided for soils that have characteristics of two groups. The system provides for both a simple field method and a laboratory method to determine the amount and type of basic constituents of the soils. Both methods are based on gradation and plasticity and vary only in degree of accuracy. The laboratory method uses mechanical analyses, liquid limit data, and plasticity indexes for exact classification. A plasticity chart on which the liquid limit and the plasticity index may be plotted is used for a more accurate classification of the fine-grained soils. Classification of the tested soils according to the Unified system is given in table 6.

Engineering test data

Table 6 shows engineering test data for samples of six different soils. The samples were taken from representative sites by the soil scientist while mapping. The testing, by the Division of Materials and Tests, Nebraska Department of Roads, was done in accordance with standard procedures of the American Association of State Highway Officials. Each soil was sampled by natural horizons. The Soil Conservation Service designates horizons as A, B, and C. Further explanation of horizon designations generally used by soil scientists are given in the Glossary of this report.

The test data in table 6 are for samples of Anselmo fine sandy loam, of Dunday loamy fine sand, of Elsmere loamy fine sand, and of Meadin loamy sand, each from one location, and of Valentine fine sand from two locations. In evaluating these data, it must be recognized that these soils vary according to location and that the data may not show the maximum range in characteristics that may be encountered.

The relation of moisture content of the soil material to density that can be achieved by compaction is very significant for many soils but considerably less significant for the sandy soils of this county.

Tests for liquid limit and plastic limit measure the effect of water on the consistence of the soil material. As the moisture content of clayey soil increases from a very dry state, the material changes from a solid to a semisolid, or plastic, state. As the moisture content is further increased, the material changes from a plastic to a liquid state. The *plastic limit* is the moisture content expressed

from six soil profiles, Thomas County, Nebr.[1]

Specific gravity	Mechanical analysis[3]							Liquid limit	Plasticity index	Classification	
	Percentage passing sieve—			Percentage smaller than—							
	No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)	0.05 mm.	0.02 mm.	0.005 mm.	0.002 mm.			AASHO[4]	Unified[5]
2. 62	100	99	36	20	10	7	5	Nonplastic	Nonplastic	A–4(0)	SM.
2. 62	100	99	45	24	13	10	8	22	3	A–4(2)	SM.
2. 59	100	98	35	18	9	8	7	Nonplastic	Nonplastic	A–2–4(0)	SM.
2. 63	100	97	14	8	4	4	3	Nonplastic	Nonplastic	A–2–4(0)	SM.
2. 65	100	98	19	10	6	4	3	Nonplastic	Nonplastic	A–2–4(0)	SM.
2. 62	100	99	19	10	6	5	4	Nonplastic	Nonplastic	A–2–4(0)	SM.
2. 54	100	98	31	19	9	5	4	Nonplastic	Nonplastic	A–2–4(0)	SM.
2. 62	100	99	28	18	8	6	5	Nonplastic	Nonplastic	A–2–4(0)	SM.
2. 63	100	98	13	5	2	2	1	Nonplastic	Nonplastic	A–2–4(0)	SM.
2. 59	100	91	19	11	6	4	3	Nonplastic	Nonplastic	A–2–4(0)	SM.
2. 65	94	56	1	1	1	1	0	Nonplastic	Nonplastic	A–3–(0)	SP.
2. 62	100	98	9	6	4	4	3	Nonplastic	Nonplastic	A–3(0)	SP–SM.
2. 65	100	98	10	6	4	4	3	Nonplastic	Nonplastic	A–3(0)	SP–SM.
2. 63	100	99	4	4	3	3	2	Nonplastic	Nonplastic	A–3(0)	SP.

In the SCS soil survey procedure the fine material is analyzed by the pipette method and the material coarser than 2 millimeters in diameter is excluded from calculations of grain-size fractions. The mechanical analyses data used in this table are not suitable for use in naming textural classes for soil.

[4] Based on AASHO Designation: M 145–49 (*1*).

[5] Based on the Unified Soil Classification System (*7*).

[6] For sample number S 62–3185 a total of 100 percent passed the ¾-inch sieve, 99 percent passed the ⅜-inch sieve, and 97 percent passed the No. 4 sieve.

as a percentage of the oven-dry weight of the soil, at which the material passes from a semisolid to a plastic state. The *liquid limit* is the moisture content at which the material passes from a plastic to a liquid state. The *plasticity index* is the numerical difference between the liquid limit and the plastic limit. It indicates the range of moisture content within which a soil material is in a plastic condition.

The mechanical analyses of the soils shown in table 6 were made to determine the distribution of the particles of different sizes. These figures show that only a small percentage of the material consists of particles less than 0.005 millimeter in size. As a result, the sandy, granular, noncohesive soils of this county are reported as nonplastic because they will not become plastic at any moisture content.

Additional detailed information on the soils of Thomas County is shown under the sections "Descriptions of the Soils," and "Genesis, Classification, and Morphology of Soils."

Brief descriptions of soils and their estimated physical properties

Engineering test data shown in table 6, together with information collected on the soil survey and experience with the same or similar soils from other counties upon which detailed test data were available, were used to describe the soils as shown in table 7. In table 7 the soils are listed, a brief description of each is given, and estimates of properties significant to engineering are shown.

The significance of some of the properties reported in table 7 are explained as follows:

Permeability refers to the rate at which water moves through the soil material in its undisturbed state. The rate depends largely on texture and structure of the soil. The permeability ratings used in this report and their

TABLE 7.—*Brief description of soils of Thomas*

Map symbol	Soil name	Description of soil and site				
		Position	Parent material	Runoff	Depth to water table	Depth to sand or sand and gravel
					Feet	*Feet*
An	Anselmo fine sandy loam	Upland valleys	Eolian sand and silt	Slow	(1)	3–20
AnB	Anselmo fine sandy loam, hummocky	Hummocky upland.	Eolian sand and silt	Moderate	(1)	3–20
B	Blown-out land	Upland	Eolian sand	Slow	(1)	0
Du	Dunday loamy fine sand	Upland valleys	Eolian sand and silt	Slow	(1)	3–10
DuB	Dunday loamy fine sand, hummocky	Upland valleys	Eolian sand and silt	Slow	(1)	3–10
DAB	Dunday-Anselmo loamy fine sands, hummocky.	See descriptions under individual soils of the series.				
Ea	Elsmere loamy fine sand	Bottom land	Alluvial sand	Very slow	3–5	2–5
Gv	Gravelly land	River breaks	Tertiary gravel	Moderate	(1)	0
Hx	Hord complex, sandy variants	High terraces	Tertiary silt, sand, and clay.	Slow	(1)	3–20
LdM	Loup fine sand and Marsh	Bottom land	Recent alluvial sand	Very slow	0–1	1
Lm	Loup loam	Bottom land	Alluvial sand	Slow	1–2	1–2
M	Marsh	Bottom land	Recent alluvium	Very slow	0	1–3
Md	Meadin loamy sand	Stream terraces	Alluvial sand and gravel.	Very slow	5–20	1–2
MD	Meadin-Dunday loamy fine sands	See descriptions under individual soils of the series.				
MDB	Meadin-Dunday loamy fine sands, hummocky.	See descriptions under individual soils of the series.				
VaC	Valentine fine sand, rolling	Rolling upland	Eolian sand	Slow	(1)	0–1
VaD	Valentine fine sand, hilly	Hilly upland	Eolian sand	Moderate	(1)	0
VcB	Valentine loamy sand, hummocky	Eroded upland	Eolian sand	Slow	(1)	0–3
VR	Valentine soils and Rough broken land	Steep river breaks	Eolian sand and Tertiary siltstone.	Rapid	(1)	1–50
Wb	Wann fine sandy loam	Stream terraces	Alluvial sand	Slow	3–6	3–5

[1] The water table is at a depth too great to be significant in engineering interpretations.

equivalent in words are shown in the following classification:

Inches per hour	*Rating*
0.05 to 0.2	Slow.
0.2 to 0.8	Moderately slow.
0.8 to 2.5	Moderate.
2.5 to 5.0	Moderately rapid.
5.0 to 10.0	Rapid.
More than 10.0	Very rapid.

Available water capacity, measured in inches of water per inch of soil, is the water available for plant consumption. It is the water held in a soil between field capacity and permanent wilting point.

All the soils of this county are quite similar in certain properties, not listed in table 7. These are briefly described in the paragraphs that follow:

Reaction of a soil, its acidity or alkalinity, is reported in terms of *pH* values. A soil with a pH of 7.0 is neutral; one with a lower pH is acid; and one with a higher pH is alkaline. In this county, the reaction of the soils varies from slightly acid (pH 6.2) to moderately alkaline (pH 8.6). The surface soil of the soils, when dry, generally has a pH of 6.5 to 6.8. Subirrigated and wet soils are generally alkaline.

Soils in this county have little or no salinity.

Dispersion is not a common property of soils in this county, as the soils are mostly coarse-grained and clay and silt fractions are predominantly low.

Shrink-swell potential is an indication of the volume change to be expected with a change in moisture content. It is estimated on the basis of the amount and type of clay. The shrink-swell potential of all soils in this county, which in general are low in fines and nonplastic, is low. In general, shrinking and swelling of the soils are not a problem.

County, Nebr., and their estimated physical properties

Depth from surface	Classification			Percentage passing sieve—			Permeability	Available water capacity
	USDA texture	Unified	AASHO	No. 4	No. 10	No. 200		
Inches							*Inches per hour*	*Inches per inch of soil*
0–36+	Fine sandy loam	SM	A–4 or A–2	100	100	30–40	2.5– 5.0	0.15
0–36+	Fine sandy loam	SM	A–4 or A–2	100	100	30–40	2.5– 5.0	.15
0–42+	Fine sand	SP or SP–SM	A–3	100	100	0–10	5.0–10.0	.08
0–18	Loamy fine sand	SM	A–2	100	100	15–25	5.0–10.0	.10
18–42+	Fine sand	SP–SM or SM	A–2	100	100	10–30	5.0–10.0	.08
0–18	Loamy fine sand	SM	A–2	100	100	15–25	5.0–10.0	.10
18–42+	Fine sand	SP–SM or SM	A–2	100	100	10–20	5.0–10.0	.08
0–8	Loamy fine sand	SM	A–2	100	100	25–35	5. 0–10. 0	. 10
8–12	Loamy sand	SM	A–2	100	100	25–35	5.0–10.0	.10
12–24	Fine sand	SP–SM or SM	A–2	100	100	10–20	5.0–10.0	.08
24+	Sand	SP–SM or SM	A–2	100	100	10–20	10+	.06
0–36+	Sand and gravel	GP or SP	A–1	50–75	25–50	2–5	10+	.04
0–11	Loamy fine sand	SM	A–2	100	100	15–25	5. 0–10. 0	. 10
11–28	Silt loam	ML	A–4	100	100	50–85	0. 8– 2. 5	. 16
28–48+	Sand	SP–SM or SM	A–2	100	100	10–20	10+	. 06
0–4	Organic matter	Pt						
4–16	Fine sand	SP, SP–SM or SM	A–2 or A–3	100	100	3–20	5. 0–10. 0	. 08
16–36+	Sand	SP or SP–SM	A–1 or A–3	100	95–100	0–10	10+	. 06
0–10	Loam	ML	A–4	100	100	50–60	0. 8– 2. 5	. 16
10–21	Fine sand	SP, SP–SM or SM	A–2 or A–3	100	95–100	3–20	5. 0–10. 0	. 08
21–36+	Sand	SP or SP–SM	A–1 or A–3	100	95–100	0–10	10+	. 06
Not estimated because of variable characteristics.								
0–7	Loamy sand	SP–SM or SM	A–2	100	100	10–20	5. 0–10. 0	. 10
7–12	Sand	SP or SP–SM	A–1 or A–3	95–100	90–95	0–10	10+	. 08
12–42+	Sand	SP or SP–SM	A–1 or A–3	95–100	90–95	0–10	10+	. 06
0–36+	Fine sand	SP–SM	A–3	100	100	5–10	5. 0–10. 0	. 08
0–36+	Fine sand	SP or SP–SM	A–3	100	100	3–10	5. 0–10. 0	. 08
0–5	SP–SM or SM	A–2	A–2	100	100	10–20	5. 0–10. 0	. 10
5–42+	Fine sand	SP or SP–SM	A–3	100	100	3–10	5. 0–10. 0	. 08
Not estimated because of variable characteristics.								
0–12	Fine sandy loam	SM	A–2 or A–4	100	100	30–40	2. 5– 5. 0	. 15
12–18	Loam	ML	A–4	100	100	50–85	0. 8– 2. 5	. 16
18–42+	Fine sand	SP, SP–SM, or SM	A–2 or A–3	100	100	3–20	5. 0–10. 0	. 08

Engineering interpretations

Table 8 shows the suitability of the soils as sources of material for topsoil, sand, and road fill and their suitability as a road subgrade.

Most of the soils in Thomas County are rated poor or fair as a source of topsoil because they are sandy and low in organic matter or natural fertility. The soils rated good as a possible source of fine sand may require extensive exploration to find material that will meet gradation requirements.

High quality sand-gravel is not readily available in Thomas County. However, limited quantities of poorly graded sand-gravel mixture may be found in the substratum of the Loup soils and the Meadin soils, and in Gravelly land along the Middle Loup and the North Loup Rivers.

The suitability of soils as road fill material is based upon compacted weights, stability, workability, and other soil characteristics. Since sand is one of the better road fill materials, soils with an AASHO classification of A–1, A–2, or A–3 were rated good. Finer grained materials (silty) were rated fair. The range in ratings shown for some soils indicates the variation in the soil material that can be expected.

The suitability of the soils as material for subgrade has been shown for pavement (bituminous and concrete) and for gravel surfacing.

TABLE 8.—*Interpretation of engineering*

Soil series and map symbols	Engineering classification		Suitability as source of—		
	Unified	AASHO	Topsoil	Sand [2]	Sand-gravel
Anselmo (An, AnB)	SM in surface soil, subsoil, and substratum.	A–4 or A–2 in surface soil, subsoil, and substratum.	Fair	(3)	(3)
Blown-out land (B)	SP or SP-SM in surface soil, subsoil, and substratum.	A–3 in surface soil, subsoil, and substratum.	Very poor	Fair	(3)
Dunday (Du, DuB)	SM in surface soil; SP–SM or SM in subsoil and substratum.	A–2 in surface soil, subsoil, and substratum.	Poor	Poor, and below depth of 18 inches.	(3)
Dunday-Anselmo (DAB)	See interpretations under Dunday and Anselmo soils.				
Elsmere (Ea)	SM in surface soil and subsoil; SP–SM or SM in substratum.	A–2 in surface soil, subsoil, and substratum.	Fair	Poor, and below depth of 24 inches.	(3)
Gravelly land (Gv)	GP or SP in surface soil, subsoil, and substratum.	A–1 in surface soil, subsoil, and substratum.	Very poor	Poor	Poor
Hord (Hx)	SM in surface soil; ML in subsoil; SP–SM or SM in substratum.	A–2 in surface soil; A–4 in subsoil; A–2 in substratum.	Poor	Poor, and below depth of 30 inches.	(3)
Loup (LdM, Lm)	Pt or ML in surface soil; SP, SP–SM, or SM in subsoil; SP or SP–SM in substratum.	Peat or A–4 in surface soil; A–2 or A–3 in subsoil; A–1 or A–3 in substratum.	Fair	Fair to poor below depth of 12 inches.	Fair to poor below depth of 24 inches.
Marsh (M)	(4)	(4)	(4)	(3)	(3)
Meadin (Md)	SP–SM or SM in surface soil; SP or SP–SM in subsoil and substratum.	A–2 in surface soil; A–1 or A–3 in subsoil and substratum.	Poor	Fair below depth of 12 inches.	Fair to poor below depth of 24 inches.
Meadin-Dunday (MD, MDB).	See interpretations under Meadin and Dunday soils.				
Valentine (VaC, VaD, VcB).	SP, SP–SM, or SM in surface soil, subsoil, and substratum.	A–3 or A–2 in surface soil, subsoil, and substratum.	Poor	Good	(3)
Valentine soils and Rough broken land (VR).	(4)	(4)	(4)	(4)	(4)
Wann (Wb)	SM in surface soil; ML in subsoil; SP, SP–SM, or SM in substratum.	A–2 or A–4 in surface soil; A–4 in subsoil; A–2 or A–3 in substratum.	Fair	Poor to good below depth of 24 inches.	(3)

[1] Because of position, topography, similarity of soils, and other reasons common to Thomas County, the interpretations of engineering properties that relate to foundations, dikes and levees, low dams, irrigation, terraces and diversions, and waterways are not shown for individual soils in this table. See the section "Engineering Interpretations."

Since sand is the best subgrade material for bituminous and concrete pavement, the ratings were determined on the same basis as that used to obtain the ratings for soil material used as road fill. Since there are no truly clayey soils in Thomas County, the lowest rating for subgrade under bituminous and concrete pavement is fair. Because sand is noncohesive, it does not provide a stable base for gravel surfacing. Thus, all soil materials in class A–3, and those materials in A–1 or A–2 that lack cohesiveness, rate as poor for subgrade for gravelled road. Some soils classed as A–1 or A–2 that have adequate cohesiveness, or plasticity, can be rated good to fair. Silty or clayey soils, which have an AASHO classification ranging from A–4 to A–7, are usually acceptable in that part of the upper subgrade that receives a gravel surfacing. Such soils are rated good to fair.

In table 8, under *features affecting highway location and agricultural drainage*, soil features are mentioned that might present problems during construction or affect maintenance costs after construction. Following are some comments on behavior of soils in the county when used for engineering.

Susceptibility to frost action.—Except for the Anselmo, Hord, Loup, and Wann soils, the soils of Thomas County are not susceptible to frost action. Any of these three exceptions may have a surface layer containing sufficient fines (particles 0.02 millimeter or less in size) and a subsoil such

properties of soils in Thomas County, Nebr.

Suitability as—			Features affecting [1]—	
Road subgrade		Road fill	Highway location	Agricultural drainage
Paved	Gravel			
Fair	Good to fair	Fair	Low to moderate susceptibility to frost action; erodible.	Rapidly permeable; drainage not needed.
Good	Poor	Good	Generally not susceptible to frost action; erodible.	Rapidly permeable; drainage not needed.
Good	Poor	Good	Generally not susceptible to frost action; erodible.	Rapidly permeable; drainage not needed.
Good to fair	Poor	Good to fair	Generally not susceptible to frost action; erodible; subject to ponding; may require 4 feet of fill.	Rapidly permeable; somewhat poorly drained because of position; seasonal high water table beneficial to grasses.
Good	Poor	Good	Not susceptible to frost action	Rapidly permeable; drainage not needed.
Good	Good to fair	Good	Low to moderate susceptibility to frost action; erodible on slopes.	Rapidly permeable; drainage not needed.
Good	Poor to good	Good to fair	High susceptibility to frost action; slopes erodible; subject to occasional flooding and ponding in spring; may require 4 feet of fill.	Somewhat poorly drained to poorly drained; outlets for drainage not available.
(5)	(5)	(5)	(5)	High water table; open drains in some places may reduce standing water.
Good	Poor	Good	Generally not susceptible to frost action; slopes erodible.	Rapidly permeable; drainage not needed.
Good	Poor	Good	Not susceptible to frost action; slopes erodible.	Rapidly permeable; drainage not needed.
(4)	(4)	(4)	(4)	Rapidly permeable; drainage not needed.
Good to fair	Poor	Good to fair	Low to moderate susceptibility to frost action; slopes erodible; subject to ponding; may require 4 feet of fill.	Rapidly permeable in the surface soil and substratum; subsoil is moderately permeable; if surface drainage is used and the areas are cultivated, irrigation may be needed in dry periods.

[2] Rating based on availability of fine sand (0.4 to 0.074 millimeter).

[3] Sand or sand-gravel of high quality generally not available.

[4] Because of variable characteristics, classification or engineering interpretation not given.

[5] Not suitable; requires special treatment.

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that water may readily move upward through it by capillary action and thus present a minor problem.

Winter grading.—The adaptability of a given soil for winter grading varies from year to year, depending on the amount of moisture in the soil and the temperatures that occur during winter. If content of moisture and temperatures are both low, winter grading is permissible, since there can be no frost without moisture. If moisture content is low, and temperatures are high enough, moisture can be added to obtain suitable conditions for grading and compaction. But in winters when temperatures are low and content of moisture is high, freezing takes place and either stops grading, earth movement, and compaction or makes these difficult to perform.

Generally, coarse-grained soils that contain only small amounts of silt and clay, as found in Thomas County, are best suited to winter grading. However, winter grading of sandy soils should be allowed only if the required standards for compaction are met.

Agricultural drainage.—Surface conditions and permeability were considered in preparing this column in table 8. Permeability ratings shown were based on the tabulation on page 29 under the heading "Permeability."

Because of the uniformity of the soils of this county, several engineering practices are not listed in table 8. Either the practices are not generally applicable, or all of the soils in the county present about the same hazards or problems in the construction and maintenance of such practices. A brief summary of these soil features that affect engineering practices follows:

Irrigation.—Soils of this county, for the most part, are too sandy, steep, or wet for irrigation. Some sprinkler irrigation is practiced on the Anselmo, Dunday, and Meadin soils and on Valentine loamy sand, hummocky, in growing alfalfa hay. These soils take in water at a moderate to rapid rate and generally are low in capacity to hold water available for plants. In most places the hummocky topography makes gravity irrigation impractical. Soils that take in 2 inches or more of water per hour are considered to have rapid intake of moisture, and those that take less than half an inch per hour, a slow intake rate. A soil rated as low in capacity to hold water is one that holds 3 to 5 inches of water in the top 4 feet of its profile. Further information on suitability of soils for irrigation can be obtained from the "Irrigation Guide for Central and Eastern Nebraska."

Low dams and structures.—Currently, there appears to be no need for low dams in the county. If used, provision would have to be made to avoid piping and to seal the reservoir area if water were to be stored.

The bearing capacity of soils at depths below 30 inches is quite uniformly good. The Anselmo, Dunday-Anselmo, Dunday, Elsmere, Wann, Hord, and Loup soils have a higher silt content at depths of less than 48 inches and would be rated fair to poor. A moderate piping hazard would be expected in these soils.

The soils of this county are, in general, good embankment materials. They have fair to high stability, and all except the silty sands are pervious. Embankments may require slope protection and foundation drains.

Dikes and levees.—Because of position, topography, and absence of flooding, dikes and levees generally are not needed or applicable. However, should low levees or dikes be built, many of the silty sands would pose problems in piping and slope erosion.

Terraces and diversions.—The topography and soils of this county are generally unsuitable for terraces and diversions, and ordinarily these are not needed.

Waterways.—The topography and land use in this county are such that waterways generally are not needed.

Wind erosion.—All the soils of Thomas County are susceptible to wind erosion where vegetative cover is not maintained.

Genesis, Classification, and Morphology of Soils

The purpose of this section is to present the outstanding morphologic characteristics of the soils of Thomas County and to relate them to the factors of soil formation. Only a few physical and chemical data are available for these soils, and the discussion of soil genesis and morphology is correspondingly incomplete. The section deals with the environment of the soils and then with the classification of the soil series according to order and great soil group. Following that, a typical soil profile of each series is described.

Factors of Soil Formation

Soil is formed by the action of soil-forming processes on materials deposited or accumulated by geologic agencies. The characteristics of the soil at any given point are determined by (1) the physical and mineralogical composition of the parent material, (2) the climate under which the soil material has accumulated and existed since accumulation, (3) the plant and animal life on and in the soil, (4) the relief, or lay of the land, and (5) the length of time the forces of soil development have acted on the soil material.

Climate and vegetation are active factors of soil genesis. They act on the parent material accumulated through the weathering of rocks and slowly change it into a natural body with genetically related horizons. The effects of climate and vegetation are conditioned by relief. The parent material also affects the kind of profile that can be formed and in extreme cases determines it almost entirely. Finally, time is needed for the changing of the parent material into a soil profile. It may be much or little, but some time is always required for differentiation of horizons. Generally, a long time is required for the development of distinct horizons.

The factors of soil genesis are closely interrelated in their effects on the soil, and few generalizations can be made regarding the effect of any one factor unless conditions are specified for the other four. Many of the processes of soil formation are not known.

Parent material.—Thomas County is in the north-central part of Nebraska, in the heart of the Sandhills region of the State.

Before Tertiary time, the part of the North American continent that now includes Thomas County was covered several times by ocean waters in which were deposited several layers of sediments that eventually formed sandstone, shale, and limestone.

During the Tertiary age, a few to many feet of outwash consisting of stratified sand and silt were deposited in this area from the Rocky Mountains. This stratified material makes up the Ogallala formation, which is now covered by a few to several hundred feet of eolian sand. The origin of this sand is not known. In this area the sand has been sorted by wind to a very uniform fine sand and blown into a complex pattern of dunes.

Locally, material from the Ogallala formation and the eolian sand have been mixed. All of the soils have developed in the eolian sand, in mixtures of eolian sand and material from the Ogallala formation, or, along flood plains and terraces in alluvium from those sources.

Climate.—Thomas County has a microthermal, subhumid climate marked by extremes in temperature and distribution of moisture. Rainfall ranges from about 11 to 29 inches and averages about 20 inches. Most of the rainfall comes during the growing season. Rainfall is sufficient to grow a good cover of grass. It also has been enough to leach lime from all the well-drained soils, except for a few finer textured ones.

Plant and animal life.—Vegetation has been very important in soil formation in this county. It stabilized the shifting sand and thus permitted development of the soil. The vegetation is mainly grasses, but it includes some forbs and small shrubs. Sedges and rushes predominate on the poorly drained soils. Cedars and a few broadleaf trees and shrubs grow mostly in small clumps along the river valleys and in a few places in the uplands.

The soils of Thomas County are those typical of grasslands. The few trees have had little effect on soil development. Organic material mostly from decay of grasses is responsible for the darkening of the surface layer of the soils.

Relief.—The relief of the soils of this county is a complex pattern of stabilized, rolling to hilly areas of sand dunes separated by nearly level to gently rolling valleys. The soils are sandy and absorb water readily, and as a result, there is little or no runoff and no defined surface drainage in most of the county. Internal drainage is rapid, and most of the excess water is removed by subsurface flow to the river valleys.

Surface drainage has a definite pattern in a few places along the river valleys. Rivers have cut deeply into the Ogallala formation. Because of the steep slopes and the fine-textured Ogallala material, there has been enough runoff to form deeply dissected drainageways in narrow areas parallel to the rivers. In the southwestern part of the county, there are a few poorly defined drainageways. In these places the upper few inches of the surface layer of the Valentine soils are finer textured than normal.

The poorly drained and imperfectly drained soils are in areas along river bottoms and terraces where the water table is high.

Time.—Soils in this county range from old to very young. They differ in apparent age, or in actual years of soil development, and in degree of development. Valentine fine sand, hilly, for instance, is a young soil. It is only weakly developed and has a thin surface layer and lacks structural development in the profile. On the other hand, Valentine fine sand, rolling, is somewhat older. It has had time to develop a thicker surface layer. Anselmo and Dunday soils are still older; they have developed thicker surface layers than Valentine fine sand, rolling, have more definite structure, and have other definite profile characteristics. The Loup soils are young soils on recent alluvium. Also formed in alluvium are the Elsmere, Wann, and Meadin soils, of intermediate age, and the Hord soils, which are somewhat older.

Classification and Morphology of Soils

Soils are placed into narrow classes for the organization and application of knowledge about their behavior within farms, ranches, or counties. They are placed into broad classes for study and comparisons of large areas such as continents. In the comprehensive system of soil classification followed in the United States (*2*), the soils are placed in six categories, one above the other. Beginning at the top, the six categories are order, suborder, great soil group, family, series, and type.

In the highest category, the soils of the whole country are grouped into three orders, whereas thousands of soil types are recognized in the lowest category. The suborder and family categories have never been fully developed and thus have been little used. Attention has largely been given to the classification of soils into soil types and series within counties or comparable areas and to the subsequent grouping of series into great soil groups and orders. The nature of the soil series, type, and phase are discussed in the section "How This Survey Was Made" and are defined in the Glossary at the back of this report.

The soil series of Thomas County are classified by order and great soil group in table 9, and the parent material, relief, and drainage of each are shown.

TABLE 9.—*Soil series classified by order and great soil group and the parent material, relief, and drainage of each*

Soil series	Order	Great soil group	Parent material	Relief	Drainage
Anselmo	Zonal	Chestnut	Eolian sand and silt	Upland valley	Good.
Dunday	Azonal	Regosol (Chestnut intergrade).	Eolian sand	Upland valley or high terrace.	Good to excessive.
Elsmere	Zonal	Chestnut (Humic Gley intergrade).	Eolian and alluvial sand	Terrace and valley	Imperfect.
Hord	Zonal	Chernozem (Regosol intergrade).	Eolian sand and alluvial silt.	High terrace	Good.
Loup	Intrazonal	Humic Gley	Alluvium	Flood plain	Poor.
Meadin	Azonal	Regosol	Eolian and alluvial sand	Terrace	Excessive.
Valentine	Azonal	Regosol	Eolian sand	Upland	Good to excessive.
Wann	Azonal	Alluvial	Alluvium	Flood plain	Imperfect.

Classes in the highest category of the classification scheme are the zonal, intrazonal, and azonal orders (*6*). The zonal order comprises soils with evident, genetically related horizons that reflect the predominant influence of climate and living organisms in their formation. In the intrazonal order are soils with evident, genetically related horizons that reflect the dominant influence of a local factor of topography or parent material over the effects of climate and living organisms. The azonal order is made up of soils that lack horizon development, commonly because of youth, resistant parent material, or steepness.

The great soil groups are described in the following pages, and the series in each group are listed. The soils in some of the series are not representative of any one great soil group but intergrade from one great soil group to another. Each series represented in the county is described under "Detailed Descriptions of Soil Series."

Chestnut soils

Chestnut soils are a zonal group of soils that have a dark-brown surface horizon that grades to lighter colored parent material. Soils of this great soil group normally have a layer of accumulated calcium carbonate 1 to 4 feet below the surface. In Thomas County, however, the lime content of the parent material was mostly low, and this lime zone is absent or only weakly developed.

The Chestnut soils in this county are of the Anselmo and Elsmere series. The Elsmere are imperfectly drained soils that intergrade to the Humic Gley great soil group.

Humic Gley soils

The Humic Gley soils are an intrazonal group of soils that developed in poorly drained areas; in this county, on bottom lands. They contain a gleyed layer, characterized by the presence of ferrous iron and neutral gray colors, which in many places are indistinct and difficult to recognize. The gleying results from intense reduction caused by poor drainage. The Loup is the only series in this great soil group in Thomas County.

Regosols

The Regosols are an azonal group of soils that show little or no horizon development. In Thomas County the Meadin, Valentine, and Dunday soils are in this great soil group. The Dunday soils in upland valleys, or on high terraces, are intergrades to the Chestnut great soil group.

In all of the soils, the organic coloring in the surface soil is the only profile development. The soils consist of deep deposits of eolian sand or of alluvial sand primarily of eolian origin. In valleys, small amounts of finer textured Ogallala material are mixed with the eolian sand.

Alluvial soils

The Alluvial soils belong to the azonal order. These soils are young. They are forming on bottom lands in alluvium derived mainly from sand and silt. Except for an accumulation of organic matter near the surface, Alluvial soils show little horizon development. In this county, the Wann is the only soil classified as Alluvial.

Chernozems

Chernozems are a zonal group of soils. The soils of this group have a dark-colored surface soil and a layer of accumulated lime in the lower part of the profile. The Hord is the only series in this great soil group in Thomas County. It is a well-drained soil that intergrades to the Regosol great soil group.

Detailed Descriptions of Soil Series

In this section the soil series are discussed and a representative profile is described for each. The great soil group is given for each series for easy cross reference to table 9.

ANSELMO SERIES

In the Anselmo series are deep, dark, well-drained soils on uplands. These soils are in the Chestnut great soil group. They have weak, granular or subangular blocky structure. Anselmo soils developed under mid and tall grasses in material from highly permeable, weakly consolidated mixtures of sandy or loamy eolian and Ogallala material.

Anselmo soils have a finer textured subsoil than the Dunday soils. They are darker colored and finer textured throughout than the Valentine soils and have a coarser textured subsoil than the Hord soils.

Variations in the Anselmo soils are chiefly in the color, texture, and thickness of the A horizon and in the texture of the substratum. The A horizon ranges from 6 to 24 inches in thickness, but it averages between 10 and 12 inches. It ranges from fine sandy loam to loamy fine sand in texture and, when dry, from brown to dark grayish brown in color. In some places the substratum consists of alternate layers of sand and sandy loam to silt loam, and in other places, it is a deep, uniform sandy loam. In some places the substratum is calcareous.

Typical profile of an Anselmo fine sandy loam (0.2 mile east and 0.1 mile south of the northwest corner of sec. 28, T. 24 N., R. 26 W.) :

A1p—0 to 3 inches, grayish-brown (10YR 5/2) fine sandy loam, very dark grayish brown (10YR 3/2) when moist; weak, granular structure that breaks to weak, medium, platy; loose when dry, very friable when moist; noncalcareous; abrupt, smooth boundary.

A12—3 to 9 inches, grayish-brown (10YR 5/2) fine sandy loam, very dark grayish brown (10YR 3/2) when moist; weak, granular structure that breaks to weak, coarse, subangular blocky; slightly hard when dry, very friable when moist; noncalcareous; clear, smooth boundary.

AC—9 to 20 inches, grayish-brown (10YR 5/2) fine sandy loam, dark grayish brown (10YR 4/2) when moist; weak, granular structure that breaks to weak, medium, blocky; slightly hard when dry, very friable when moist; noncalcareous; gradual, smooth boundary.

C—20 to 36 inches, very pale brown (10YR 7/3) fine sandy loam, pale brown (10YR 6/3) when moist; weak, crumb structure that breaks to weak, medium, blocky; slightly hard when dry, very friable when moist.

DUNDAY SERIES

The Dunday series is made up of deep, well-drained, noncalcareous, grayish-brown loamy fine sands that have a subsoil of fine sand or loamy sand. These soils are in the Regosol great soil group but are intergrading toward the Chestnut great soil group. They are in upland valleys and on high terraces. Anselmo soils developed under grass in a mixture of material from eolian sand and Ogallala silt. They have weak, subangular blocky structure that breaks to fine crumb or single grain. The substratum is a fairly uniform fine sand.

Dunday soils have a finer textured, thicker surface layer than the Valentine soils and a coarser textured subsoil than the Anselmo or Hord soils. They are better drained than the Elsmere and Wann soils, which are imperfectly drained.

The A horizon ranges from 6 to 24 inches in thickness, but it averages between 10 and 12 inches. Its color ranges from brown to dark grayish brown when dry. The AC horizon is transitional to the underlying material, which is light gray to very pale brown when dry. On terraces, the substratum is alluvial sand and gravel at a depth of 3 to 6 feet.

Typical profile of a Dunday loamy fine sand (0.2 mile south and 0.1 mile west of the northeast corner of sec. 23, T. 23 N., R. 27 W.):

A—0 to 10 inches, dark grayish-brown (10YR 4/2) loamy fine sand, very dark grayish brown (10YR 3/2) when moist; weak, medium, subangular blocky structure; soft when dry, very friable when moist; noncalcareous; pH 6.6; gradual, smooth boundary.

AC—10 to 18 inches, light brownish-gray (10YR 6/2.5) fine sand, grayish brown 10YR 5/2) when moist; single grain; loose when dry or moist; noncalcareous; pH 7.0; gradual, smooth boundary.

C—18 to 42 inches, light-gray (10YR 7/2) fine sand, grayish brown (10YR 5.5/2) when moist; single grain; loose when dry or moist; noncalcareous; pH 7.2.

ELSMERE SERIES

The Elsmere series is made up of deep, grayish-brown to brownish-gray loamy fine sands that are imperfectly drained. These soils are in the Chestnut great soil group, but they are intergrading toward Humic Gley soils. They are on terraces or in upland valleys. Elsmere soils have weak, subangular blocky structure that breaks to soft granular or crumb structure. They developed in sandy alluvium where the water table was moderately high.

These soils are coarser textured throughout the profile than the Wann soils. They are lighter colored than the Loup soils and have a lower water table.

Elsmere soils are fairly uniform wherever they occur. They vary chiefly in depth to the substratum of sand and gravel, which is below 16 inches. In the shallower soils damage from drought occurs if the water table drops as low as the substratum.

Typical profile of Elsmere loamy fine sand (0.4 mile west of the center of sec. 22, T. 24 N., R. 30 W.):

A1—0 to 8 inches, gray (10YR 5/1) loamy fine sand, very dark grayish brown (10YR 3/2) when moist; weak, fine, granular structure; soft when dry, loose when moist; noncalcareous; pH 7.8; clear, smooth boundary.

AC—8 to 12 inches, grayish-brown (10YR 5.5/1) loamy sand, very dark grayish brown (10YR 3.5/2) when moist; weak, medium, subangular blocky structure; slightly hard when dry, very friable when moist; slight effervescence with acid; pH 8.4; abrupt, smooth boundary.

C1—12 to 24 inches, light-gray (10YR 7/2) fine sand, light brownish gray (10YR 6/2) when moist; single grain; loose when dry or moist; noncalcareous; pH 8.4; gradual, smooth boundary.

C2—24 inches +, light-gray (5Y 7/2) weakly stratified coarse sand and fine gravel, light olive gray (5Y 6/2) when moist; single grain; loose when dry or moist; noncalcareous; pH 8.4.

HORD SERIES

In the Hord series are deep, well-drained, nearly level soils on terraces. These soils are in the Chernozem great soil group, but they are intergrading toward the Regosol great soil group. They are medium textured to fine textured, and the material in the surface layer in some places has been sorted by wind. In Thomas County Hord soils developed on geologic terraces in material of Tertiary age. The native vegetation was mid and tall grasses.

The surface layer, a grayish-brown loamy fine sand, ranges from 4 to 24 inches in thickness, but it averages about 10 inches. Below is 1 to 5 feet of silt loam to clay loam alluvium. In most places the upper part of the alluvium is a buried soil. The substratum, at a depth below 3 to 6 feet, is very pale brown sand that contains gravel in some places.

Hord soils have a finer textured subsoil than the Anselmo soils. They are better drained than the imperfectly drained Wann soils.

Typical profile of a Hord loamy fine sand (0.2 mile north and 0.2 mile west of the center of sec. 2, T. 24 N., R. 26 W.):

A1—0 to 11 inches, dark grayish-brown (10YR 4.5/2) loamy fine sand, very dark grayish brown (10YR 3/2) when moist; weak, medium, granular structure; slightly hard when dry, very friable when moist; noncalcareous; pH 6.8; clear, smooth boundary.

A1b—11 to 18 inches, dark grayish-brown (10YR 4.5/2) silt loam, dark brown (7.5YR 3/2) when moist; moderate, coarse, platy structure; hard when dry, friable when moist; noncalcareous; pH 6.4; clear, smooth boundary.

C1—18 to 28 inches, light-gray (10YR 7/2) silt loam, grayish brown (10YR 5.5/2) when moist; moderate, medium, granular structure; hard when dry, friable when moist; noncalcareous; pH 6.8; clear, smooth boundary.

C2—28 to 42 inches, very pale brown (10YR 7/3) sand, light brownish gray (10YR 6/2) when moist; single grain; loose when dry or moist; noncalcareous; pH 7.0.

LOUP SERIES

The Loup series is made up of poorly drained, very dark grayish-brown or black soils of the bottom lands. These soils are in the Humic Gley great soil group. They have weak to moderate, granular structure. Loup soils developed in material from washed sand, silt, and clay, where the water table was high. In places they are calcareous near the surface.

These soils are darker colored than the Elsmere soils, have a higher water table, and have coarser sand and gravel near the surface.

In many places an A0 horizon overlies the A1. The A0 horizon consists of 1 to 4 inches of grayish-brown (10YR 5/2), partly decayed organic matter that is dark grayish brown (10YR 4/2) when moist. The A horizon ranges from 4 to 14 inches in thickness, but it averages about 8 inches. It is thicker and finer textured where depth to the water table is farthest from the surface. In many places the AC horizon is missing, especially in those places where the water table is high. The C horizon ranges from light gray to very pale brown in color. Its texture ranges from fine sand, in the uppermost part of the profile, to sand and gravel at a greater depth.

Typical profile of Loup loam (0.2 mile north and 0.1 mile east of center of sec. 22, T. 24 N., R. 30 W.):

A1—0 to 8 inches, dark-gray (10YR 4/1) loam, very dark gray (10YR 3/1) when moist; weak, fine, granular structure; friable when moist, slightly hard when dry; many roots; strong effervescence at a depth of 0 to 3 inches; pH 7.2; abrupt, clear boundary.

AC—8 to 10 inches, pale-brown (10YR 6/3) silt loam, brown (10YR 4/2.5) when moist; weak, medium, subangular blocky structure; noncalcareous; pH 7.4; very friable when moist, hard when dry; many fine roots; clear, smooth boundary.

C1—10 to 21 inches, light-gray (10YR 7/2) fine sand, grayish brown (10YR 5/2) when moist; many, distinct iron stains; weak, coarse, prismatic structure that breaks to single grain; loose when moist or dry; gradual, smooth boundary; pH 8.0.

C2—21 to 36 inches, light-gray (10YR 7/1) sand and gravel, gray (10YR 6/1) when moist; many, distinct iron stains; single grain; water table at a depth of 22 inches; pH 8.0.

MEADIN SERIES

In the Meadin series are well-drained, nearly level, loamy sands on terraces. These soils are shallow or moderately deep over gravel. They are in the Regosol great soil group. Their surface layer is nearly structureless or is weakly granular. Meadin soils developed under grass in alluvial sand and gravel.

These soils have a coarser textured subsoil than the Dunday soils and are better drained than the imperfectly drained Elsmere soils.

The Meadin soils vary chiefly in their depth to sand and gravel, which ranges from 8 to 36 inches.

Typical profile of a Meadin loamy sand (0.3 mile north of the center of sec. 12, T. 24 N., R. 26 W.):

A1—0 to 7 inches, dark grayish-brown (10YR 4.5/2) loamy sand, very dark grayish brown (10YR 3/2) when moist; weak, fine, granular structure; soft when dry, very friable when moist; pH 6.4; clear, wavy boundary.

AC—7 to 12 inches, brown (10YR 5.5/3) sand, dark grayish brown (10YR 4.5/2) when moist; single grain; loose when dry and moist; pH 6.2; gradual, wavy boundary.

C—12 to 42 inches, light-gray (10 YR 7/2) stratified sand and gravel, light brownish gray (10YR 6/2) when moist; single grain; loose when dry or moist; pH 7.0.

VALENTINE SERIES

The Valentine series is made up of deep, loose, sandy soils on hills and hummocks in the uplands. These soils are in the Regosol great soil group. The surface layer, a grayish-brown, structureless, fine sand, averages about 6 inches in thickness and is lighter colored with increasing depth. The substratum is a uniform, very pale brown, loose, fine sand.

These soils have a thinner and coarser textured surface layer than the Anselmo or Dunday soils. They are fairly uniform fine sand throughout the profile. In a few places, however, the surface layer is loamy sand or loamy fine sand and is less than 6 inches thick.

Typical profile of Valentine fine sand, rolling (0.15 mile north and 0.15 mile west of the center of sec. 13, T. 23 N., R. 26 W.):

A1—0 to 6 inches, dark grayish-brown (10YR 4.5/2) fine sand, very dark grayish brown (10YR 3/2) when moist; single grain; loose when dry or moist; noncalcareous; pH 6.5; abrupt, smooth boundary.

AC—6 to 10 inches, brown (10YR 5.5/3) fine sand, dark brown (10YR 4.5/3) when moist; single grain; loose when dry or moist; noncalcareous; pH 6.7; gradual, smooth boundary.

C—10 to 36 inches, very pale brown (10YR 7/3) fine sand, brown (10YR 5.5/3) when moist; single grain; soft when dry, loose when moist; noncalcareous; pH 7.0.

WANN SERIES

In the Wann series are imperfectly drained, moderately sandy soils on terraces. These soils are in the Alluvial great soil group. They have weak, granular or subangular blocky structure. Wann soils developed under grass, where the available soil moisture was abundant, in material from washed sand, silt, and clay. In undisturbed areas Wann soils are calcareous near the surface, but if cultivated and irrigated, they are calcareous only at a depth below 20 inches.

These soils are darker colored and finer textured than the Elsmere soils. They are lighter colored and better drained than the Loup soils. Wann soils are similar to the Hord soils, but they are imperfectly drained instead of well drained.

Typical profile of Wann fine sandy loam (0.4 mile north of the southeast corner of sec. 7, T. 23 N., R. 28 W.):

A1p—0 to 6 inches, dark-gray (10YR 4/1) fine sandy loam, black (10YR 2/1.5) when moist; weak, coarse, platy structure that breaks to weak, medium, granular; soft when dry, very friable when moist; noncalcareous; pH 6.6; clear, smooth boundary.

A12—6 to 12 inches, dark grayish-brown (10YR 4/2) fine sandy loam, very dark brown (10YR 2/2) when moist; weak, medium, subangular blocky structure; soft when dry, friable when moist; weak effervescence with acid; pH 6.4; clear, wavy boundary.

A1b—12 to 18 inches, very dark gray (2.5YR 3/1) loam, black (2.5Y 2/0) when moist; weak, fine, granular structure; slightly hard when dry, friable when moist; violent effervescence with acid; pH 7.8; abrupt, smooth boundary.

AC—18 to 30 inches, grayish-brown (10YR 5.5/2) fine sand, dark grayish brown (10YR 4/2) when moist; single grain; loose when dry or moist; weak effervescence with acid; pH 8.6; gradual, smooth boundary.

C—30 to 42 inches, light-gray (10YR 7/2) fine sand that contains a few scattered iron stains and a few fine pebbles, light brownish gray (10YR 6/2) when moist; single grain; loose when dry or moist; noncalcareous; pH 8.6.

General Nature of the County

This section provides general information about the geology, relief, and drainage of the county. It also gives facts about the climate, natural resources, settlement and development, transportation and markets, and agriculture. The statistics used are mainly from reports of the U.S. Bureau of the Census.

Geology, Relief, and Drainage

The Ogallala geologic formation is exposed in various places along the steep slopes of river valleys in Thomas County. Where exposed, the material consists of various layers of soft, nearly white, very fine to medium sand and nearly white to grayish-brown silty to sandy clay.

In most places the Ogallala formation is covered with a few to a hundred feet of eolian fine sand. This sand covers much of the area, and most of the soils in the county developed from it.

The wind has blown the sand into a complex pattern of various sized dunes separated in places by nearly level to gently rolling valleys. Establishment of vegetation that stabilized the dunes varied in rate and pattern and has modified the shape of the dunes in many places. Small, secondary dunes have formed on the large dunes in many

places. Generally, the dunes have very steep south slopes and longer, more gradual north slopes. The higher dunes are generally steeper and rougher than the lower dunes. The dunes consist mostly of nearly uniform fine sand, but in a few places, mostly on the south side of valleys, the uppermost few inches is loamy sand or loamy fine sand.

The nearly level to gently rolling valleys between the dunes range in width from a few feet to one-half mile or more. Generally, the soils in these valleys have a surface layer of loamy fine sand. In a few places, however, silt from the Ogallala formation has been mixed with the eolian sand and the soils have a finer textured surface soil of sandy loam. In some places, mostly in the eastern half of the county, Ogallala silt has been mixed with eolian sand to form finer textured layers in the substratum of the soil.

Three rivers drain the area—the Dismal River, which crosses the southern part of the county from west to east; the Middle Loup River, which flows through the county near the center; and the North Loup River, which flows across the northeast corner.

Drainage in the county is excellent. Only alluvial soils in low areas along the rivers are wet and subirrigated. Water readily infiltrates and percolates through the sandy soils; thus, little rainfall is lost through runoff. Except for the river channels, drainageways are short and are only in areas where fine materials are exposed along the valley slopes.

The valley of the Dismal River is narrow and the area of alluvial soils along it is small. Valleys of the Middle and North Loup Rivers are as much as one-half mile wide, and most of the alluvial soils are there. The alluvial soils consist mostly of a surface layer of loamy fine sand underlain by alluvial sand and gravel at a depth of a few inches to 6 or more feet. Narrow areas of Marsh commonly border the rivers, and these areas are submerged most of the year.

Except for the valleys along the North and Middle Loup Rivers, which influenced the location of roads, railroads, and towns, and the Bessey Division of the Nebraska National Forest in the Choppy Sandhills, the differences in geographic association of the soils have had little influence on land use. Variations in use of the different associations are mainly in the proportion of soils suitable for use for crops or for hay.

Because the early settlers looked for water and soils suitable for farming, first the river valleys were settled and then the areas where Dunday and Anselmo soils were most abundant. The rougher areas, predominantly Valentine soils, were the last to be settled and were the first areas to be converted from general farming to ranching.

Climate[6]

Thomas County is in north-central Nebraska in the heart of the Sandhills. The climate is distinctly continental. Rainfall is light, winters are cold, summers are warm, and the weather changes sharply from day to day and from season to season. The elevation of the county ranges from a little less than 2,800 feet in the eastern part to 3,200 feet in the western part. This increase in elevation is part of a general rise in elevation that continues to the west and ends at the Continental Divide in Wyoming. At this latitude open areas in the mountains permit frequent passage of strong westerly winds during winter and early in spring. The mountain barrier is high enough, however, to cut off most of the moisture from the Pacific Ocean and to modify substantially air masses from the northern Pacific. No other major climatic barriers exist, and cold air masses from Canada move freely into the area with little change en route.

Climatic data for the county are summarized in tables 10, 11, 12, 13, and 14. The data are from the Halsey Station of the U.S. Weather Bureau, which is about 2 miles west of Halsey and near the northeast boundary of the Bessey Division of the Nebraska National Forest.

Most of the precipitation that falls in the county originates in the Gulf of Mexico and is carried northward on the west side of the Bermuda High. Local sources of moisture have little effect on the climate, since no large bodies of water are in or near the county. The three rivers that cross the county are fed by ground water and flow continuously. On bright, warm days their shallow waters heat rapidly, and the rate of evaporation into the normally dry air is increased correspondingly.

The climate in the county favors the growth of grass. Since the soils are very sandy and blow if not protected, much of the native prairie has never been broken. Agriculture in the county is based on the raising of livestock that graze on the range in summer and are fed on hay from the meadows in winter. Nearly all of the soils on the bottom lands have been left in natural meadows. Less than 1 percent of the total acreage is in grain, and a similar acreage is planted to alfalfa. The dry weather in winter and spring is unfavorable for the natural spread of trees. Nevertheless, trees thrive if planted and cared for until the roots reach the permanently moist subsoil.

Frequent, high winds cause blowouts, particularly in paths worn by cattle on their way to watering tanks. The use of "drift fences," which are placed across normal pathways and force the cattle to approach water tanks from various routes, helps prevent the wearing of deep paths. Relocating the fences from time to time keeps the sod unbroken and helps prevent exposure to the wind. On the other hand, the wind hinders insect activity and, therefore, affords some degree of protection from such pests to cattle grazing the range. The wind also serves as a source of power for the many small windmills that dot the range and pump fresh water for the cattle. If the wells are placed a mile or two apart, better management of the range is promoted because daily moving of the herd is reduced and grazing is controlled in local areas.

The winters are marked by light precipitation and alternate periods of cold and mild weather. Temperature changes are frequent and sharp and sometimes severe. In 1936, for example, the temperature dropped below freezing on January 22, and it stayed below freezing for 30 days. The average temperature for this period was 3.3 degrees below zero. The temperature was below zero on all but 4 nights, and it stayed below zero the entire day for 8 different days.

Generally, most precipitation in winter falls as snow when the weather is turning colder. The snow usually does not last long because of the frequent periods of mild weather. As a rule, the ground is bare or has less than an

[6] By RICHARD M. MYERS, State climatologist, U.S. Weather Bureau.

TABLE 10.—*Temperature and precipitation at Halsey, Thomas County, Nebr.*

Month	Temperature [1]				Precipitation				
	Average daily maximum	Average daily minimum	Two years in 10 will have at least 4 days with—		Average monthly total [1]	One year in 10 will have—		Days with a snow cover of 1 inch or more	Average depth of snow on days with snow cover [1]
			Maximum temperature equal to or higher than—	Minimum temperature equal to or lower than—		Equal to or less than [2]—	Equal to or more than [2]—		
	°F.	°F.	°F.	°F.	Inches	Inches	Inches	Number	Inches
January	35.6	10.2	56	−15	0.47	0.07	0.81	11	4.8
February	38.6	13.2	61	−7	.65	.11	1.45	13	5.2
March	47.2	21.8	69	3	1.27	.18	2.38	10	4.9
April	61.0	33.9	81	21	2.24	.53	4.80	2	3.0
May	72.4	45.5	87	32	3.54	1.26	5.81	[3]	2.9
June	82.4	55.4	97	43	3.32	1.00	5.64	0	0
July	89.9	61.1	102	51	2.42	.98	4.91	0	0
August	88.0	59.7	99	49	2.61	.82	4.77	0	0
September	78.0	49.0	96	34	1.89	.30	3.28	0	0
October	67.0	36.4	85	25	1.03	.13	2.54	[3]	3.6
November	49.0	23.2	68	5	.60	[4]	1.80	3	2.3
December	39.6	15.6	58	−2	.48	.05	1.44	9	4.4
Year	62.4	35.4	[5]103	[6]−19	20.52	14.85	29.13	48	4.6

[1] Data based on period of 1933 through 1962.
[2] Data based on period of 1903 through 1962.
[3] Less than half a day.
[4] Trace.
[5] Average annual highest maximum.
[6] Average annual lowest minimum.

TABLE 11.—*Temperature and precipitation extremes at Halsey, Nebr., from 1903–1962*

Month	Temperature				Precipitation			
	Highest	Year	Lowest	Year	Driest	Year	Wettest	Year
	°F.		°F.		Inches		Inches	
January	74	1911	−34	1915	[1]	1961 [2]	1.89	1944
February	78	1904	−32	1905	[1]	1910	2.13	1953
March	91	1946	−24	1948	0.07	1916	4.02	1927
April	98	1910	−7	1936	.13	1907	6.71	1905
May	101	1934	18	1909	.57	1940	8.04	1951
June	109	1952	27	1919	.67	1950	9.21	1962
July	115	1954	39	1915 [2]	.56	1954	8.06	1928
August	108	1954 [2]	35	1928	.23	1955	6.33	1957
September	103	1948 [2]	11	1926	0	1944	4.62	1909
October	96	1947	−2	1925	0	1933	6.82	1930
November	82	1909	−18	1940	0	1939 [2]	3.49	1928
December	75	1939	−27	1920 [2]	0	1943	1.99	1913
Year	115	1954	−34	1915	13.72	1934	35.24	1915

[1] Trace.
[2] Also in earlier year or years.

inch of snow cover for about two-thirds of the time in winter. Severe blizzards are infrequent, but when they occur they cause problems for the rancher. For instance, in January 1949, repeated heavy snows totaled nearly 3 feet and were accompanied by strong winds and low temperatures. Roads were blocked by snow. Temperatures remained below freezing most of the time and frequently dropped below zero. Snow was blown back into the roads as fast as they were cleared, and moving feed to the cattle was difficult.

Snowfall increases the latter part of February, reaches a maximum in March, and then continues well into April. Some snow falls in May in about one-fourth of the years. The spring snows provide welcome moisture and give the grass a good start, but are unfavorable for livestock. The character of the snowfall in late winter and spring is important in connection with calving during this period, since cattle are generally not turned out to summer range until about May 15. Calving is done in the open, and wet, sticky snows that cling to the cows and calves at near freezing temperatures are particularly hazardous. Cattle can withstand weather better if the snow is dry and falls from them, even though the temperature is low, than if the snow is wet and sticky. Formerly, the main calving date

was scheduled for May because of improved weather conditions at that time, and the calves were held over until the following year and sold as yearlings. The current practice of selling calves in fall requires an earlier calving date.

A study of the snows falling from 1933 through 1962 shows that there are few 15-day periods in January, February, and March without measurable snow. Most of the snow that falls in January and February is dry, and temperatures are generally in the 10 to 20 degree range and often fall to zero or below by the end of the snowfall or soon after. Snows in January and February are accompanied by strong, shifting winds that often pile the snow into deep drifts. Occasionally, the precipitation begins as rain and changes to snow and the temperature remains close to freezing. When the precipitation ends, the temperature turns much colder.

Disagreeable weather is common in March and April. Temperatures fluctuate widely, and many days are windy. In March the character of the snow changes frequently. Generally, the snow that falls at the beginning of the

TABLE 12.—*Probabilities of last freezing temperatures in spring and first in fall at Halsey, Nebr.*

Probability	Dates for given probability and temperature				
	16° F.	20° F.	24° F.	28° F.	32° F.
Spring:					
1 year in 10, later than	April 16.	April 23.	May 5.	May 17.	May 26.
2 years in 10, later than	April 11.	April 18.	April 29.	May 12.	May 21.
5 years in 10, later than	April 1.	April 7.	April 19.	May 1.	May 10.
Fall:					
1 year in 10, earlier than	October 20.	October 16.	October 6.	September 24.	September 13.
2 years in 10, earlier than	October 26.	October 21.	October 12.	September 29.	September 18.
5 years in 10, earlier than	November 6.	October 31.	October 22.	October 10.	September 27.

TABLE 13.—*Precipitation by month for 10 wettest years at Halsey, Nebr., from 1903 through 1962*

Month	1915	1962	1957	1930	1906	1927	1949	1905	1951	1938
January	1. 57	0. 09	0. 08	0. 80	0. 40	0. 40	1. 77	0. 55	0. 19	0. 20
February	1. 56	. 74	. 05	. 20	. 17	. 12	. 19	. 18	. 41	. 46
March	2. 26	1. 76	1. 37	. 18	. 84	4. 02	3. 68	2. 96	. 57	2. 38
April	5. 83	. 99	3. 38	4. 52	6. 37	5. 69	2. 79	6. 71	2. 28	6. 24
May	3. 20	7. 94	7. 35	4. 28	2. 49	4. 98	4. 46	5. 33	8. 04	4. 30
June	6. 29	9. 21	2. 58	4. 89	2. 63	4. 13	3. 84	4. 18	4. 52	3. 37
July	3. 00	7. 67	3. 96	1. 04	1. 79	2. 41	2. 86	4. 75	3. 27	1. 62
August	4. 09	1. 51	6. 33	4. 77	5. 84	2. 81	3. 70	. 89	2. 36	5. 48
September	3. 94	1. 82	2. 02	. 68	3. 17	2. 13	2. 54	1. 32	3. 99	1. 85
October	1. 94	. 67	1. 96	6. 82	[1] 3. 25	. 34	1. 45	1. 12	. 83	. 09
November	. 14	[2]	1. 81	1. 23	1. 11	. 80	. 44	. 45	. 61	. 36
December	1. 42	. 39	. 63	. 75	1. 45	1. 30	. 87	[2]	[1] 1. 92	. 06
Year	35. 24	32. 79	31. 52	30. 16	[1] 29. 51	29. 13	28. 59	28. 44	[1] 27. 99	26. 41

[1] Partly or wholly estimated.

[2] Trace.

TABLE 14.—*Precipitation by month for 10 driest years at Halsey, Nebr., from 1903 through 1962*

Month	1934	1952	1937	1936	1955	1956	1921	1940	1922	1931
January	[1]	0. 81	0. 52	0. 59	0. 53	0. 72	0. 30	0. 41	0. 71	0. 23
February	. 61	1. 12	. 18	. 36	1. 45	. 57	. 90	. 48	. 23	. 74
March	. 67	. 95	. 44	. 56	. 54	. 16	. 79	. 71	. 38	1. 38
April	. 54	1. 38	2. 23	2. 12	1. 65	1. 99	1. 06	2. 05	2. 31	. 69
May	1. 09	3. 75	1. 89	3. 97	2. 52	1. 23	3. 88	. 57	2. 35	2. 01
June	2. 09	. 98	2. 35	1. 96	3. 25	2. 28	. 99	3. 59	1. 10	1. 06
July	1. 29	1. 36	. 91	. 98	1. 37	1. 60	2. 14	. 70	4. 40	3. 18
August	1. 99	1. 97	1. 85	1. 60	. 23	3. 30	2. 52	2. 37	1. 40	3. 36
September	4. 34	. 26	1. 87	1. 24	1. 36	. 30	. 95	. 78	. 42	1. 60
October	. 25	. 23	1. 42	. 50	. 52	1. 60	1. 23	1. 45	. 19	. 35
November	. 21	. 63	. 21	. 06	. 43	. 92	. 06	. 80	1. 97	. 44
December	. 64	. 39	. 31	. 42	. 70	. 18	. 18	1. 21	. 03	. 53
Year	13. 72	13. 83	14. 18	14. 36	14. 55	14. 85	15. 00	15. 12	15. 49	15. 57

[1] Trace.

month is cold and dry, but as the month progresses the snowfall becomes wet and sticky. By the end of the month, temperatures lower than 10 to 15 degrees following a snowfall are rare. Precipitation in March comes as rain, as snow, as rain and snow mixed, as rain changing to snow, and even sometimes as snow followed by rising temperatures and rain. In the 30-year period from 1933 through 1962, there were 12 years with no measurable snow in the first half of April and 16 years with none in the second half of the month. All of the snows in April were wet and sticky, and many of them were associated with cold rains.

Snow is infrequent in May. From 1933 through 1962, there were 26 years without measurable snow during the first half of the month and 29 years when no snow fell during the second half of the month. In May the precipitation comes mostly in the form of showers and thunderstorms, which reach a peak late in May and early in June. Hail falls at times, but it seldom does much damage to the range. Late in June, the moist air from the Gulf of Mexico is replaced by drier air from the west, and precipitation declines.

The weather in summer, with mild temperature, low humidity, and an almost constant breeze, is pleasant. The grass cover of the soils keeps the soils cooler than plowed soils and also helps to keep the air temperature in check during the afternoon. The dry air and fairly high elevation permit rapid cooling after sundown. Temperatures in the afternoon generally range between 85 and 95 degrees, but fall to between 55 and 65 degrees during most nights.

Sunshine is abundant in fall. The days are warm and bright, the nights are clear and cool, and precipitation is slight. The first freezing temperature normally is late in September. Hard freezes occur the latter part of October. By the end of November, the average temperature is at freezing and winter is at hand. The cool dry weather cures the range grasses, which provide good pasture for some months after growth has ceased. Cattle frequently are pastured on these cured grasses through December, and in favorable years as late as February. During this period it is advisable to feed the cattle a protein supplement. Grazing of the cured grasses conserves the supply of hay so that it can be fed to the cows before calving, when it is most needed.

In the following list are the monthly amounts of potential evapotranspiration, in inches, as computed by the Thornthwaite method from mean temperatures at Halsey, for the period 1933 through 1962. December, January, and February are not included, because the mean temperature in those months is below 32 degrees.

March	0.21	August	5.40
April	1.54	September	3.30
May	3.19	October	1.73
June	4.93	November	0.22
July	6.11		

Natural Resources

The most important resources of the county are grass and water. Native grass covers more than 95 percent of the area and provides excellent range for cattle. The county has an abundant supply of underground water used mainly to provide water for the livestock and for domestic use. A limited amount of the water is used for irrigation.

A few native trees grow along the rivers, and most ranchers have established windbreak plantings around their headquarters and, in places, in pastures. About 80,000 acres of land is in the Bessey Division of the Nebraska National Forest, and about one-fourth of it has been planted to trees. Much of the rest is grazed under Forest Service grazing permits, and approximately 5,000 cattle graze these lands for 6 months in the warmer seasons. Little commercial use is made of the timber.

Some sand and gravel is pumped from areas along the river for use for roads or in concrete. In some places silt is mined from open pits that extend into the Ogallala formation. The silt is used mainly in mixture with native sand for building roads.

A more detailed discussion of one of the most important resources of the county—the vegetation—is given in the paragraphs that follow.

Vegetation

The common and scientific names of the principal plants in Thomas County are given in the list that follows.

GRASSES

Common name	*Scientific name*
Big bluestem	*Andropogon gerardi*
Blue grama	*Bouteloua gracilis*
Bluejoint reedgrass	*Calamagrostis canadensis*
Common reed	*Phragmites communis*
Kentucky bluegrass	*Poa pratensis*
Little bluestem	*Andropogon scoparius*
Northern reedgrass	*Calamagrostis inexpansa*
Prairie cordgrass	*Spartina pectinata*
Prairie sandreed	*Calamovilfa longifolia*
Sand bluestem	*Andropogon hallii*
Sand lovegrass	*Eragrostis trichodes*
Scribner panicum	*Panicum scribnerianum*
Side-oats grama	*Bouteloua curtipendula*
Switchgrass	*Panicum virgatum*
Tumblegrass	*Schedonnardus paniculatus*
Western wheatgrass	*Agropyron smithii*

HERBS, FORBS, AND SEDGES

Common name	*Scientific name*
American licorice	*Glycyrrhiza lepidota*
Arrowhead	*Sagittaria* spp.
Beeplant	*Cleome serrulata*
Bulrush	*Scirpus* spp.
Burreed	*Sparganium* spp.
Cattail	*Typha latifolia*
Common evening primrose	*Oenothera biennis*
Daisy fleabane	*Erigeron ramosus*
Goldenrod	*Solidago* spp.
Gray sagewort	*Artemisia* spp.
Green sagewort	*Artemisia* spp.
Gromwell	*Lithospermum* spp.
Heath aster	*Aster ericoides*
Indigobush amorpha	*Amorpha fruticosa*
Leadplant	*Amorpha canescens*
Mentzelia	*Mentzelia decapetala*
Penstemon	*Penstemon* spp.
Pricklepoppy	*Argemone intermedia*
Soapweed	*Yucca glauca*
Stiff sunflower	*Helianthus rigidus*
Tall sedges	*Carex* spp.
Western ragweed	*Ambrosia psilostachya*
Wooly plantain	*Plantago purshii*

SHRUBS AND TREES

Common name	*Scientific name*
American plum	*Prunus americanus*
Bessey cherry	*Prunus besseyi*
Chokecherry	*Prunus virginiana*
Coralberry	*Symphoricarpos orbiculatus*
Green ash	*Fraxinus lanccolata*
Hackberry	*Celtis occidentalis*
Plains poplar	*Populus sargentii*
Redcedar	*Juniperus virginiana*
Skunkbush sumac	*Rhus trilobata*
Wild rose	*Rosa* spp.
Willow	*Salix* spp.

Settlement and Development

Thomas County was settled by cattlemen during the 1870's. The cattlemen grazed their cattle on the open range until nearly the turn of the century. Homesteading started in the county about 10 years later, and in 1887 the county was organized. In about the same year, the Chicago, Burlington & Quincy Railroad extended a line through the county, which encouraged homesteading and hastened settlement.

Most of the homesteaders were farmers from the East and South. These settlers occupied small homesteads, farmed the land intensively, and plowed up much sandy land not suited for cultivation. Little was done to protect the soils from erosion.

In 1904 when the Kinkaid Act was passed, which increased the amount of land that could be acquired by an individual homesteader to 640 acres, almost half the county was still under Government ownership. Those who acquired the increased acreage soon learned that under intensive farming even 640 acres was not sufficient to provide an adequate income. Generally, the homesteaders had a few cattle, and they raised grain on the sandy soils for their hogs and chickens. Eventually, more than 70,000 acres were cultivated. For a few years yields were good, but then they decreased.

Continued farming of soils not suited to cultivation, without protecting them, caused severe wind erosion that affected even the soils suited to tillage. This, combined with the severe drought of the 1930's, caused farming to decline, and much of the cultivated land was returned to grazing. Many homesteaders sold out to cattlemen, and ranching again became dominant in the county. The size of ranches in the county increased from 1,496 acres in 1930, to 2,001 acres in 1940, and to 4,445 acres in 1959. Only remnants of old "soddies" and a few old fields not yet returned to grazing remain as a reminder of the years of intensive farming.

The population of the county decreased from 1,773 in 1920 to 1,078 in 1960. The main towns are Halsey, Seneca, and Thedford, the county seat.

The county has churches of several denominations, located in the main towns. Thomas County is divided into nine grammar school districts, of which six operated schools in 1960. The Thomas County High School is in Thedford, and another high school is in Halsey. Nearly 90 percent of the students attend school in the main towns.

Service and social clubs are active in the county. School and community athletic events and rodeos provide recreation for many. In addition, good hunting and fishing are available.

Transportation and Markets

Railroad transportation is provided for the county by a line of the Chicago, Burlington & Quincy Railroad Company that runs from Lincoln to Alliance. Paralleling the railroad is State Highway No. 2, which is hard surfaced. U.S. Highway No. 83 crosses the county from north to south near the middle of the county. Parts of the county are served by one-lane blacktop roads and graveled roads, but many ranches still can be reached only by traveling several miles of sandhill trails.

A ready market for livestock from the county and adjacent areas is provided at Thedford.

Agriculture

Most agriculture in the county is based on the raising of cattle. All but 5 percent of the land is in grass used for hay or pasture. Corn, rye, vetch, and alfalfa are the main cultivated crops grown, and they occupy less than 5,000 acres.

In 1959 there were 86 farms and ranches in the county. Of these, 30 were operated by full owners, 45 by part owners, and 11 by managers or tenants. The headquarters of several large ranches are located in adjacent counties.

The number of cattle and calves reported in the county in 1959 was about 26 thousand. On some ranches calves born in spring are sold in fall, but on most ranches the calves are kept through the winter and sold the next fall as yearlings. The calves on a few ranches are carried over another year and sold as 2-year-olds. The sale of the older animals permits more winter grazing and is better suited to a ranch operation if labor is scarce or if the acreage of highly productive soils in hay is small.

A successful ranch operation depends on keeping operating costs low. Sandhill ranchers early recognized the need for developing and using machinery and practices that would save labor. Consequently, most ranchers have electricity and use it to provide heating and power for pumps and other electrical equipment.

The use of horse-drawn vehicles in the county is rare. Economical transportation is provided, even where roads are lacking, by four-wheel drive vehicles.

Labor costs are reduced through the use of tractors on the ranches. On many ranches, for example, two mowers are operated by one man on a tractor. In this way, a swath 14 to 16 feet wide can be cut at one time. Bunchers are used on mowers, rather than rakes, on some ranches. By this method, the job is done in one operation and a mulch is left on the soil for protection against soil splash from rainfall. The mulch also provides protection from runoff and from wind erosion. Wide rakes that make a 40- to 60-foot swath are used along with fast, motorized sweeps and stackers on some ranches. The resulting 4- to 6-ton stacks are hauled on a low wagon bed to the feeding area and fed on the ground.

If hay is baled, power loaders are commonly used. Many ranchers mow parts of their winter range and leave the bales or windrows on the field to be fed in winter. Electric fences are used to limit the area that is to be grazed at any one time. In this way, little hay that is cut is wasted. Furthermore, it is more economical for cattle to range for their winter feed than to haul the feed to them.

Thomas County ranchers are fully mechanized and use modern methods in managing their ranches. Production testing is practiced by several ranchers. Insect control is practiced on all ranches. Prairie fires, which formerly were a primary hazard to all residents, have been brought under control by practicing fire prevention and using modern firefighting equipment.

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Glossary

Aggregate, soil. Many fine particles held in a single mass or cluster, such as a clod, crumb, block, or prism.

Alluvial soil. A soil developing in transported and relatively recently deposited material (alluvium) with little or no modification of the original materials by soil-forming processes.

Alluvium. Fine material, such as sand, silt, or clay, that has been deposited on land by streams.

Animal-unit month. The amount of forage or feed required to maintain one animal unit for a period of 30 days.

Association, soil. A group of soils geographically associated in a characteristic repeating pattern.

Blowout. An excavation produced by wind action in loose soil, generally sand.

Bottom land. Nearly level land that borders streams and is subject to flooding; often referred to as a flood plain.

Calcareous soil. Soil that contains enough calcium carbonate (often with magnesium carbonate) to form bubbles visible to the naked eye when treated with cold, dilute hydrochloric acid. Soil that is alkaline in reaction because of the presence of free calcium carbonate.

Channeled. Cut by small watercourses.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Climax vegetation. The stabilized plant community on a particular site; it reproduces itself and does not change so long as the environment does not change.

Colluvium. Soil material, rock fragments, or both, near the base of fairly steep slopes. The deposits have accumulated through soil creep, slides, and local wash.

Complex, soil. A mapping unit consisting of different kinds of soils in such small areas or in such intricate patterns that they cannot be indicated separately on a map of the scale used.

Consistence. The feel of the soil and the ease with which a lump is crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent; will not hold together in a mass.

Friable.—When moist, crushes easily under gentle to moderate pressure between thumb and forefinger, and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Soft.—When dry, soil mass is very weakly coherent and fragile; breaks into a powder or individual grains under very slight pressure.

Hard.—When dry, moderately resistant to pressure; barely breakable between thumb and forefinger.

Decreasers. Any of the climax plants most heavily grazed. Because they are the most palatable, they are the first to be destroyed by overgrazing.

Dune. A mound or ridge of sand piled up by the wind.

Eolian (aeolian) soil material. Soil parent material accumulated by wind action; commonly refers to sandy material in dunes.

Evapotranspiration. The loss of water from a soil by evaporation and transpiration.

Forb. Any herbaceous plant, neither a grass nor a sedge, that is grazed on western ranges.

Great soil group (soil classification). A broad group of soils that have fundamental characteristics in common.

Horizon, soil. A layer of soil, approximately parallel to the soil surface, that has distinct characteristics produced by soil-forming processes. These are the major soil horizons:

A horizon. The mineral horizon at the surface. It has an accumulation of organic matter, has been leached of soluble minerals and clay, or shows the effects of both. The major A horizon may be subdivided into A1, the part that is dark colored because of organic material, and A2, the part that is leached and light colored.

B horizon. The horizon in which clay minerals or other material has accumulated, or that has developed a characteristic blocky or prismatic structure, or that shows the characteristics of both processes. It may be subdivided into B1, B2, or B3 horizons.

C horizon. The unconsolidated material immediately under the true soil.

Increasers. Species in the climax vegetation that increase in relative amount as the more desirable plants are reduced by close grazing; they are commonly shorter than decreasers, and some are less palatable to livestock.

Invaders. Plants that come in and grow after the climax vegetation has been reduced by grazing.

Mapping unit. All areas of a named kind of soil, soil complex, or miscellaneous land type shown on the soil map and identified by a symbol.

Massive. Large uniform masses of cohesive soil, sometimes with ill-defined and irregular cleavage, as in some of the fine-textured alluvial soils; structureless.

Mottling, soil. Contrasting patches of color that vary in number and size. Descriptive terms for mottling are as follows; *Contrast*—faint, distinct, and prominent; *abundance*—few, common, and many; and *size*—fine, medium, and coarse. Mottling in a soil generally indicates poor aeration and restricted drainage.

Munsell color notation. A system for designating color by degrees of the three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color with a hue of 10YR, value of 6, and a chroma of 4.

Permeability. The quality of the soil that enables it to transmit water or air.

Phase, soil. In this report, a subdivision of the soil type, based on differences in the soil type that affect management but do not affect kind, thickness, and arrangement of layers in the soil profile. Actually, a phase can be a subdivision of a soil series, soil type, or other unit in the natural, or taxonomic, classification of soils.

Profile, soil. A vertical section of the soil through all its horizons and extending into the parent material. See Horizon, soil.

Range sites. Kinds of rangeland that differ in ability to produce a significantly different kind or amount of climax, or original, vegetation. A significant difference is a difference large enough to require different grazing use or management to maintain or improve the range.

Range condition. The present state of vegetation on a range site in relation to climax conditions for that site.

Reaction, soil. The degree of acidity or alkalinity of the soil mass, expressed in pH values or in words as follows:

	pH		*pH*
Extremely acid	Below 4.5	Neutral	6.6 to 7.3
Very strongly acid	4.5 to 5.0	Mildly alkaline	7.4 to 7.8
Strongly acid	5.1 to 5.5	Moderately alkaline	7.9 to 8.4
Medium acid	5.6 to 6.0	Strongly alkaline	8.5 to 9.0
Slightly acid	6.1 to 6.5	Very strongly alkaline	9.1 and higher

Relief. The elevation or inequalities of the land surface, considered collectively.

Runoff. Surface drainage of rain or melted snow.

Sand. Individual rock or mineral fragments in soils that have diameters ranging from 0.05 to 2.0 millimeters. Most sand grains consist of quartz, but they may be of any mineral composition. The textural class name of any soil that contains 85 percent or more of sand and not more than 10 percent of clay.

Series, soil. A group of soils developed from a particular kind of parent material and that have genetic horizons similar, except for the texture of the surface soil, in differentiating characteristics and in arrangement in the profile. A soil series may include two or more soil types that differ from one another in the texture of the surface soil.

Silt. Individual mineral particles in a soil that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). Soils of the silt textural class are 80 percent or more silt and less than 12 percent clay.

Soil. A natural, three-dimensional body on the earth's surface that supports plants and that has properties resulting from the integrated effect of climate and living matter acting upon parent material, as conditioned by relief, over periods of time.

Solum. The upper part of a soil profile, above the parent material, in which the processes of soil formation are active.

Structure, soil. The arrangement of primary soil particles into compound particles or clusters that are separated from adjoining aggregates and have properties unlike those of an equal mass of unaggregated primary soil particles. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. Structureless soils are (1) *single grain* (each grain by itself, as in dune sand) or (2) *massive* (the particles adhering together without any regular cleavage, as in many claypans and hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the soil profile below plow depth.

Substratum. Any layer lying beneath the solum, or true soil; the C or D horizon.

Surface layer. The topmost layer in the soil profile, regardless of the thickness of this layer.

Surface soil. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, about 5 to 8 inches in thickness.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. (See Clay, Sand, and Silt.) The basic textural classes, in order of increasing proportions of fine particles are as follows: *Sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay.*

Type, soil. A subdivision of the soil series that is made on the basis of differences in the texture of the surface layer.

Winnowed soil. Soil from which the wind has removed the finer particles.

GUIDE TO MAPPING UNITS, RANGE SITES, AND CAPABILITY UNITS

[See table 1, p. 6 for approximate acreage and proportionate extent of each soil; table 3, p. 17 for predicted yields on soils cultivated; and table 4, p. 22, for trees suitable for planting in windbreaks. For information significant to engineering, see section beginning p. 24. Dashes indicate Marsh was not assigned to a range site because it was not suited to the use]

Map symbol	Soil name	Page	Range site		Capability unit	
			Name	Page	Symbol	Page
An	Anselmo fine sandy loam	6	Sandy	13	IIe–3	19
AnB	Anselmo fine sandy loam, hummocky	6	Sandy	13	IVe–3	19
B	Blown-out land	6	Sands	12	VIe–5	20
DAB	Dunday-Anselmo loamy fine sands, hummocky	7	Sandy	13	IVe–5	19
Du	Dunday loamy fine sand	7	Sandy	13	IVe–5	19
DuB	Dunday loamy fine sand, hummocky	7	Sandy	13	IVe–5	19
Ea	Elsmere loamy fine sand	7	Subirrigated	14	IVw–5	19
Gv	Gravelly land	7	Shallow to Gravel	14	VIIs–4	20
Hx	Hord complex, sandy variants	8	Sandy	13	IVe–5	19
LdM	Loup fine sand and Marsh	8	Wet Land	14	Vw–5	19
Lm	Loup loam	8	Subirrigated	14	Vw–1	19
M	Marsh	9			VIIIw–1	20
Md	Meadin loamy sand	9	Shallow to Gravel	14	VIIs–4	20
MD	Meadin-Dunday loamy fine sands	9	Sandy	13	IVe–5	19
MDB	Meadin-Dunday loamy fine sands, hummocky	9	Sandy	13	IVe–5	19
VaC	Valentine fine sand, rolling	10	Sands	12	VIe–5	20
VaD	Valentine fine sand, hilly	10	Choppy Sands	13	VIIe–5	20
VcB	Valentine loamy sand, hummocky	10	Sands	12	VIe–5	20
VR	Valentine soils and Rough broken land	10	Thin Breaks	14	VIIs–3	20
Wb	Wann fine sandy loam	10	Subirrigated	14	IIIw–6	19

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If you have other disabilities and wish to file a program complaint, please see the contact information above. If you require alternative means of communication for

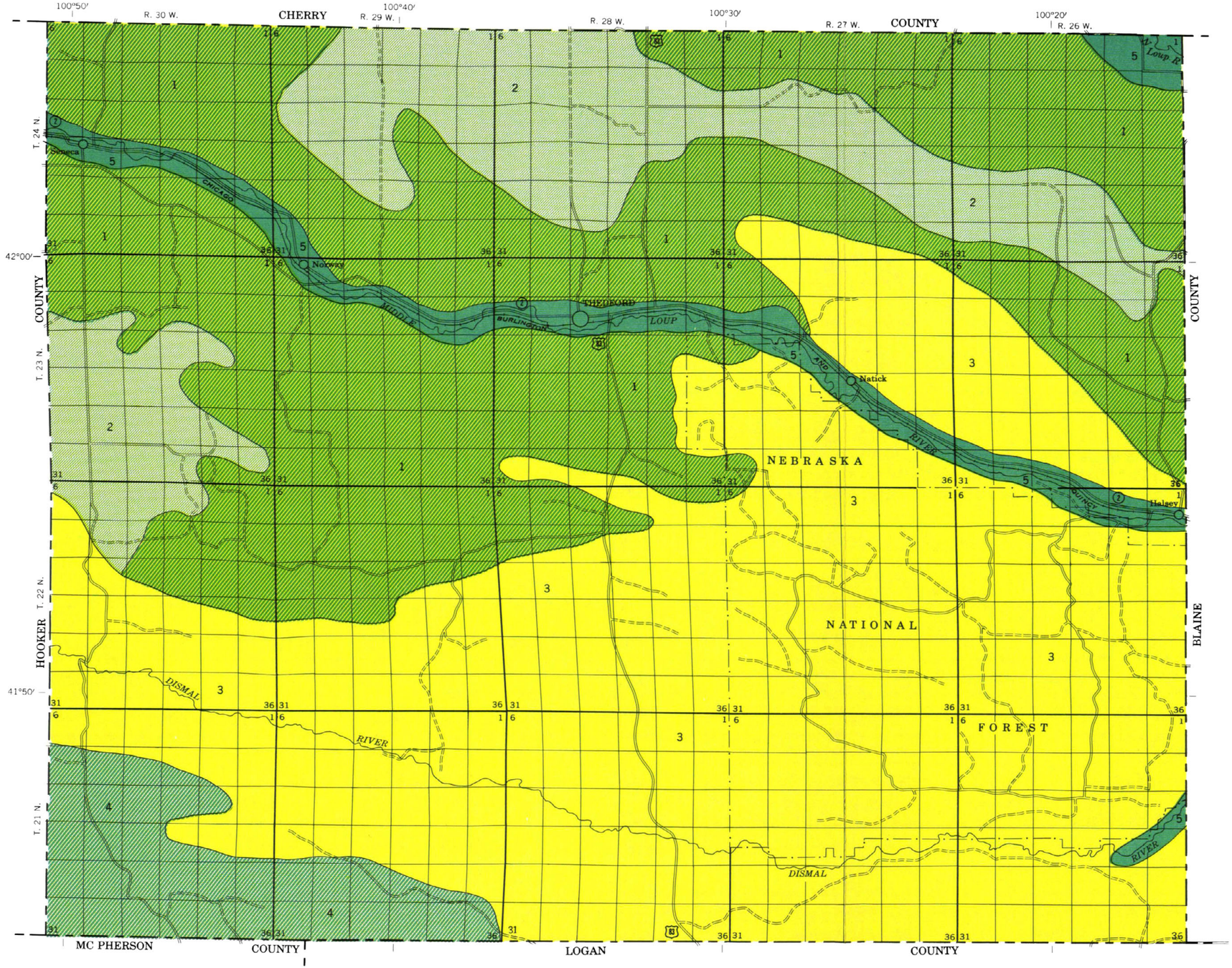
program information (e.g., Braille, large print, audiotape, etc.), please contact USDA's TARGET Center at (202) 720-2600 (voice and TDD).

Supplemental Nutrition Assistance Program

For additional information dealing with Supplemental Nutrition Assistance Program (SNAP) issues, call either the USDA SNAP Hotline Number at (800) 221-5689, which is also in Spanish, or the State Information/Hotline Numbers (http://directives.sc.egov.usda.gov/33085.wba).

All Other Inquiries

For information not pertaining to civil rights, please refer to the listing of the USDA Agencies and Offices (http://directives.sc.egov.usda.gov/33086.wba).



U. S. DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE

UNIVERSITY OF NEBRASKA CONSERVATION AND SURVEY DIVISION

GENERAL SOIL MAP

THOMAS COUNTY, NEBRASKA

SOIL ASSOCIATIONS

1 Valentine, rolling, association: Rolling sandhills

2 Valentine, rolling-Anselmo association: Rolling sandhills and swales

3 Valentine, hilly, association: Choppy sandhills

4 Valentine, hilly-Dunday association: Choppy sandhills and swales

5 Dunday-Loup association: River valleys

August 1964

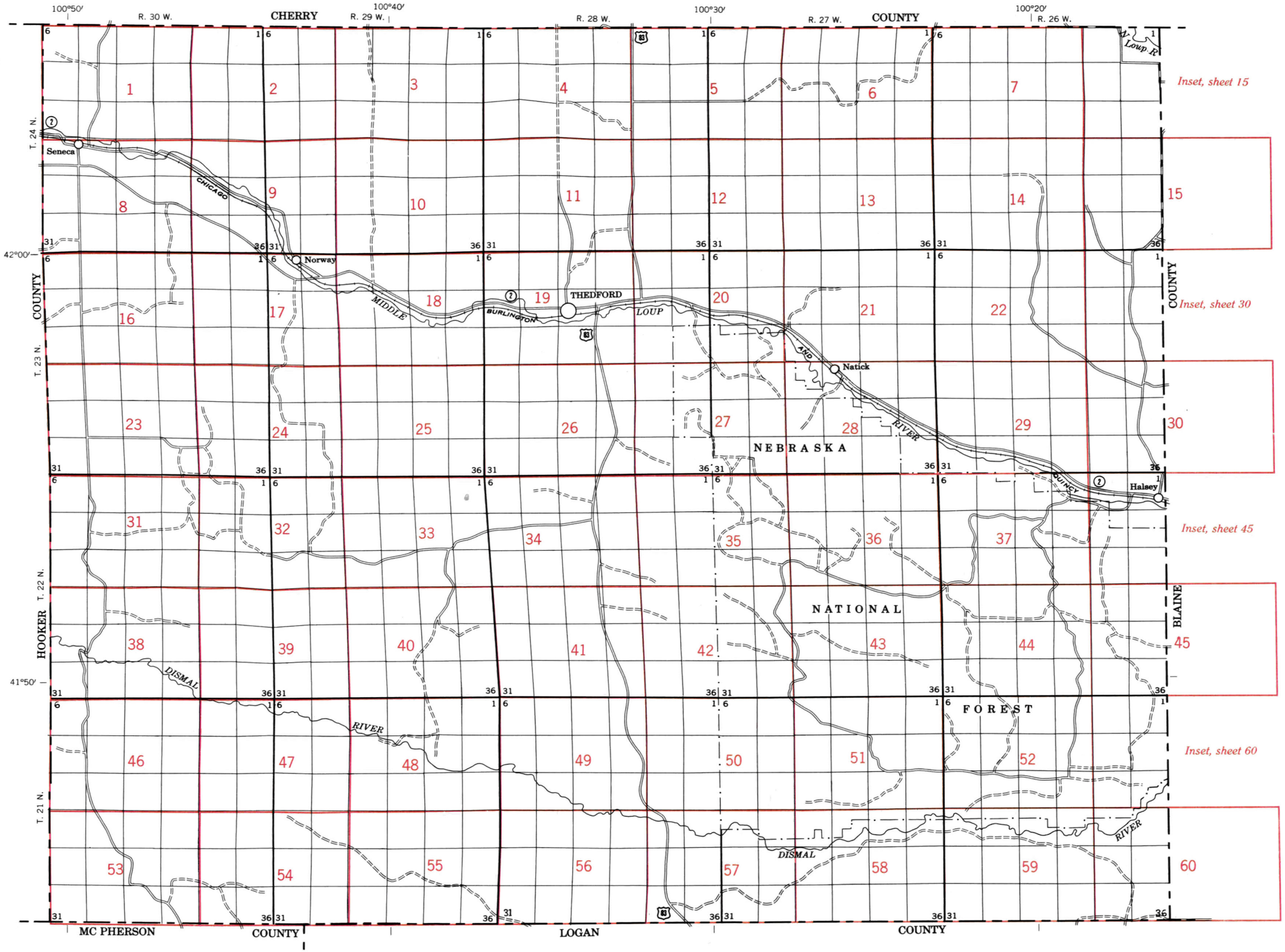
N

Scale 1:190080

1 0 1 2 3 4 5 Miles

INDEX TO MAP SHEETS

THOMAS COUNTY, NEBRASKA



N

Scale 1:190080

1 0 1 2 3 4 5 Miles

CONVENTIONAL SIGNS

WORKS AND STRUCTURES

Highways and roads

- Dual
- Good motor
- Poor motor
- Trail

Highway markers

- National Interstate
- U. S.
- State

Railroads

- Single track
- Multiple track
- Abandoned

Bridges and crossings

- Road
- Trail, foot
- Railroad
- Ferries
- Ford
- Grade
- R. R. over
- R. R. under
- Tunnel

- Buildings
- School
- Church
- Station

- Mines and Quarries
- Mine dump
- Pits, gravel or other
- Forest fire or lookout station
- Firebreak
- Cemeteries
- Dams
- Fence
- Fence on road
- Fence on County line
- Windmills
- Tank or trough

BOUNDARIES

- National or state
- County
- Township, U. S.
- Section line, corner
- Reservation
- Land grant

DRAINAGE

Streams

- Perennial
- Intermittent, unclass.

- Canals and ditches (CANAL / DITCH)

Lakes and ponds

- Perennial
- Intermittent

- Wells, Irrigation wells (I.W.)
- Springs
- Marsh
- Wet spot
- Alluvial fan

RELIEF

Escarpments

- Bedrock
- Other

- Prominent peaks

Depressions

	Large	Small
Crossable with tillage implements		
Not crossable with tillage implements		
Contains water most of the time		

SOIL SURVEY DATA

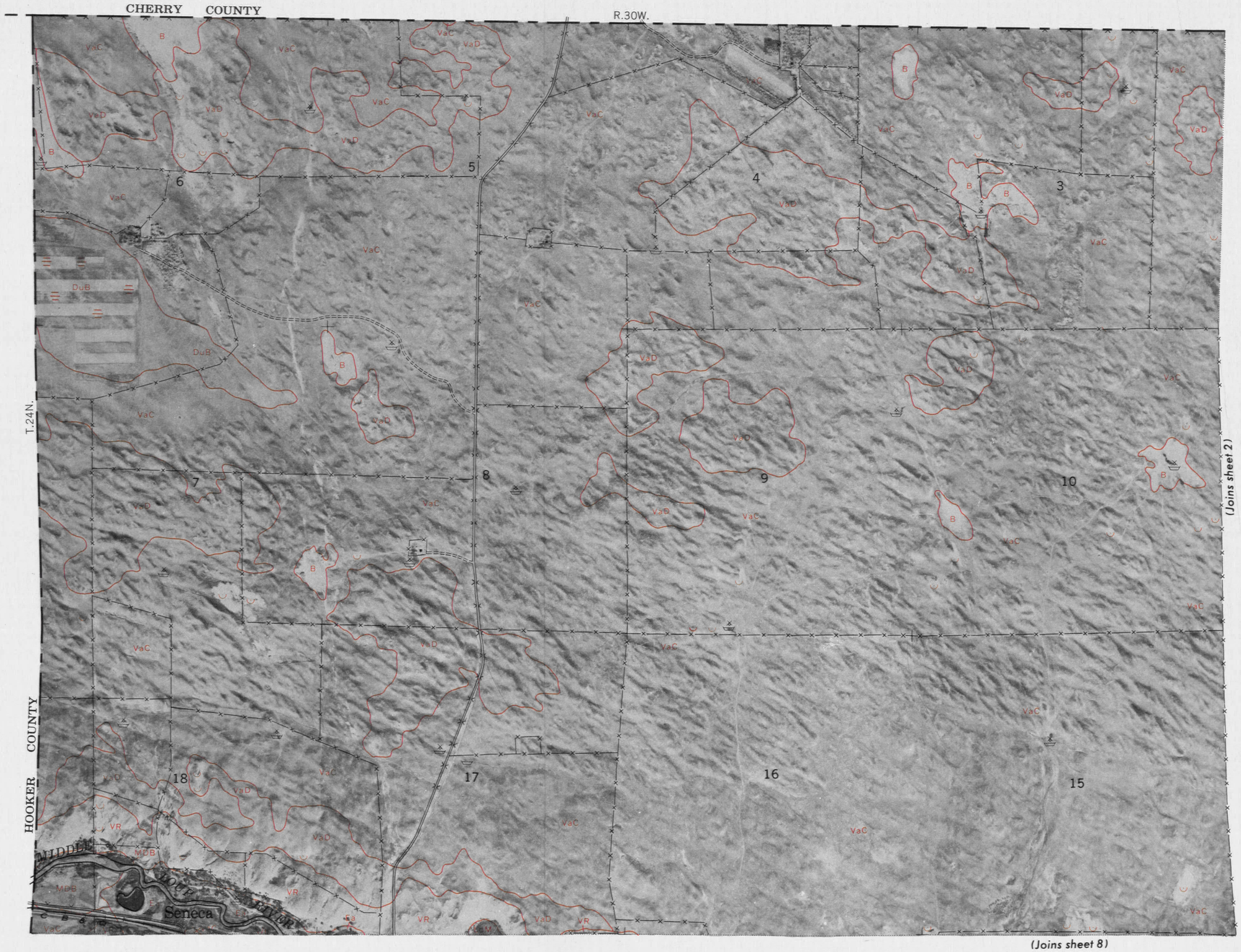
- Soil boundary and symbol (Dx)
- Gravel
- Stones
- Rock outcrops
- Chert fragments
- Clay spot
- Sand spot
- Gumbo or scabby spot
- Made land
- Severely eroded spot
- Blowout, wind erosion
- Gullies
- Short steep slope

SOIL LEGEND

The first letter, a capital, in each symbol is the initial one of the soil name. If the second letter is a capital it is the initial of another part of the soil name. A third capital letter, A, B, C, or D, is used to show the slope if slope forms part of the soil name.

SYMBOL	NAME
An	Anselmo fine sandy loam
AnB	Anselmo fine sandy loam, hummocky
B	Blown-out land
DAB	Dunday-Anselmo loamy fine sands, hummocky
Du	Dunday loamy fine sand
DuB	Dunday loamy fine sand, hummocky
Ea	Elsmere loamy fine sand
Gv	Gravelly land
Hx	Hord complex, sandy variants
LdM	Loup fine sand and Marsh
Lm	Loup loam
M	Marsh
Md	Meadin loamy sand
MD	Meadin-Dunday loamy fine sands
MDB	Meadin-Dunday loamy fine sands, hummocky
VaC	Valentine fine sand, rolling
VaD	Valentine fine sand, hilly
VcB	Valentine loamy sand, hummocky
VR	Valentine soils and Rough broken land
Wb	Wann fine sandy loam

Soil map constructed 1964 by Cartographic Division, Soil Conservation Service, USDA, from 1955 aerial photographs. Controlled mosaic based on Nebraska plane coordinate system, north zone, Lambert conformal conic projection, 1927 North American datum.



This map is one of a set compiled in 1964 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Conservation and Survey Division, University of Nebraska, University of Nebraska.

Range, township, and section corners shown on this map are indefinite.

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

10

N

R.29W.

T.24N.

(Joins sheet 3)

(Joins sheet 9)

(Joins sheet 11)

(Joins sheet 18)

21 22 23 24

28 27 26 25

33 34 35 36

DuB B VaC VaD

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

R.28W.

(Joins sheet 4)

11

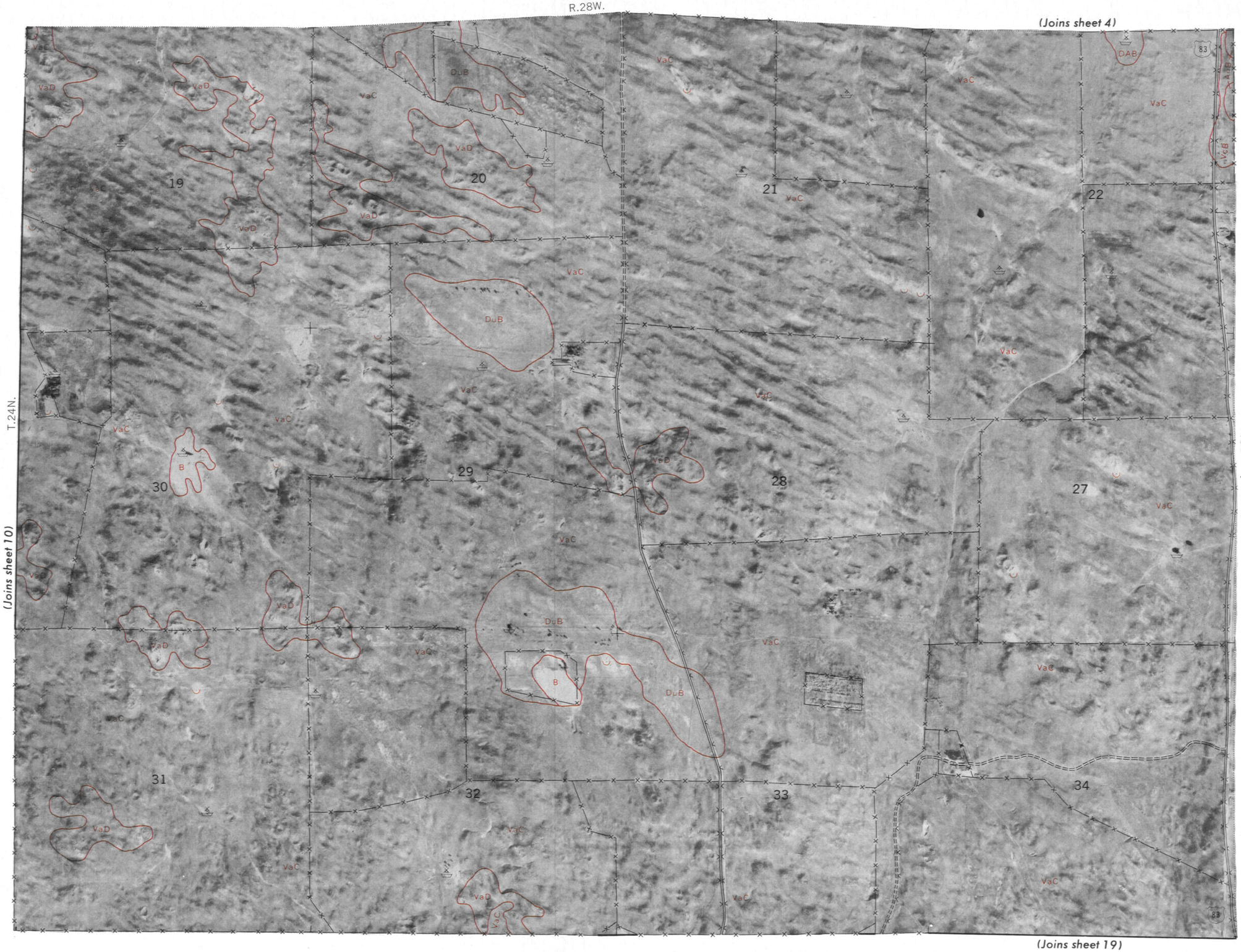
N

T.24N.

(Joins sheet 10)

(Joins sheet 12)

(Joins sheet 19)



0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

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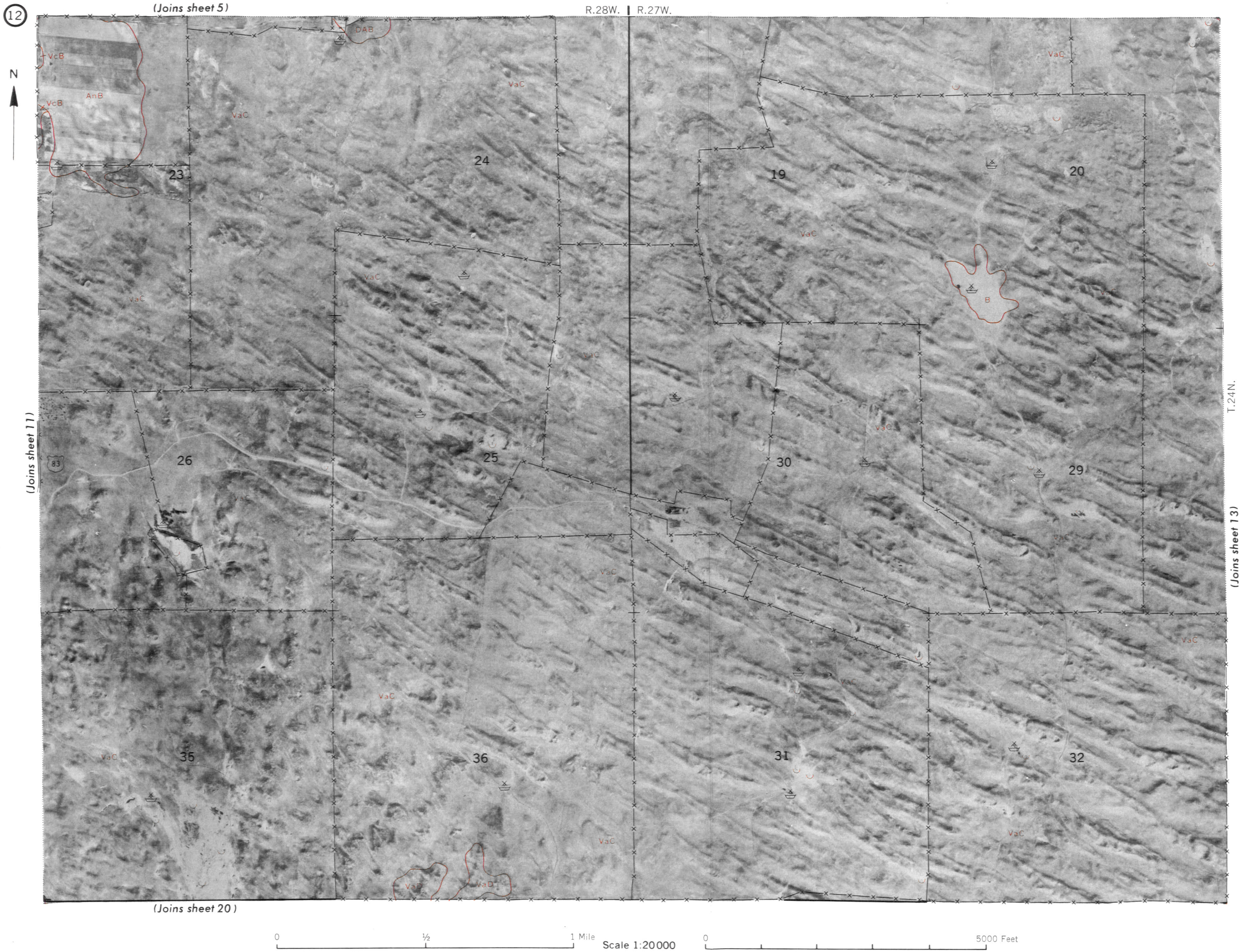
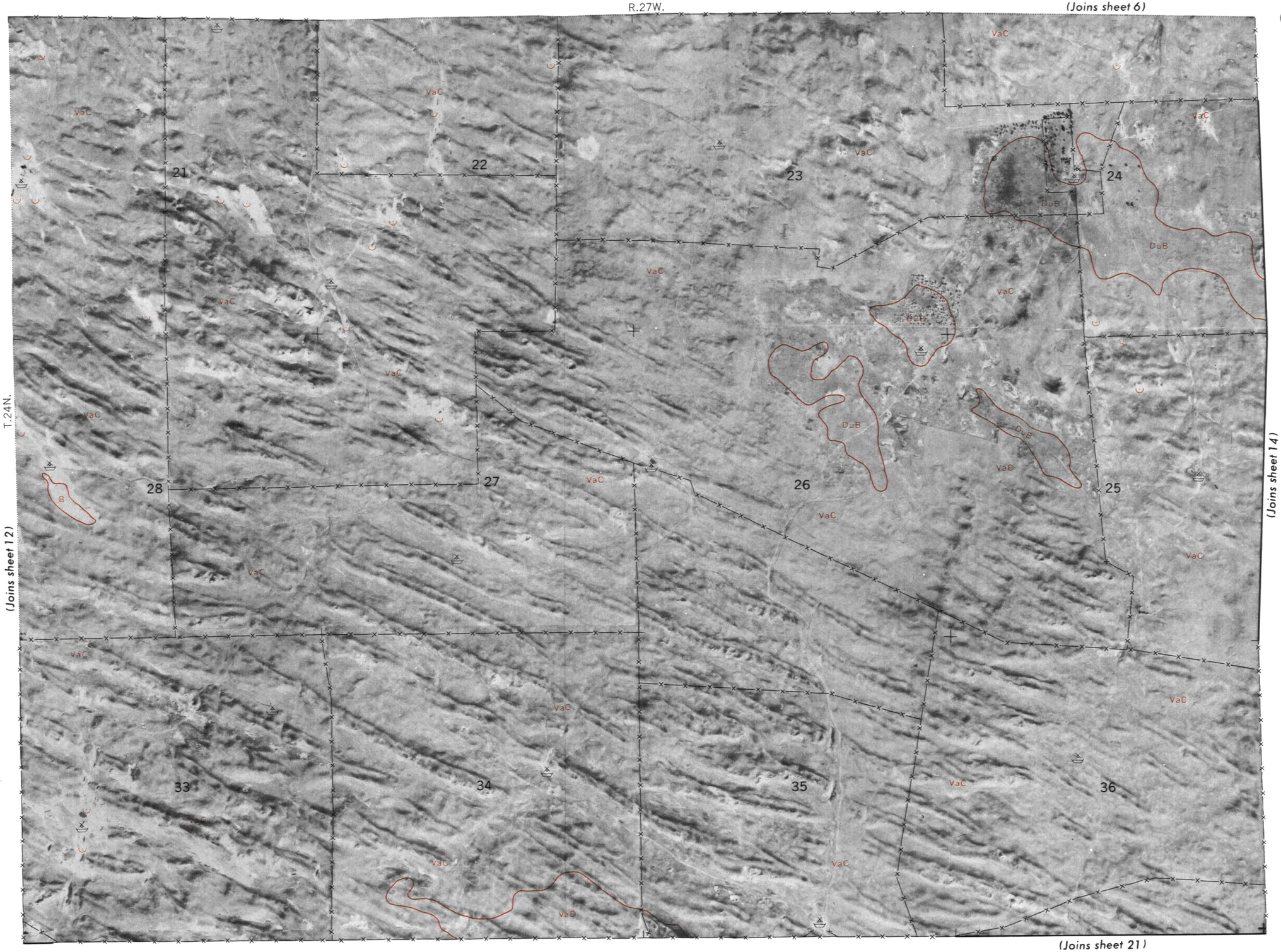
THOMAS COUNTY, NEBRASKA — SHEET NUMBER 12



R.27W.

(Joins sheet 6)

T.24N.



(Joins sheet 12)

(Joins sheet 14)

(Joins sheet 21)

N

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

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(Joins sheet 7)

R.26W.

(14)

N

19 20 21 22

30 29 28 27

31 32 33 34

T.24N.

(Joins sheet 13)

(Joins sheet 15)

(Joins sheet 22)

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

This map is one of a set compiled in 1964 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Conservation and Survey Division, University of Nebraska.

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R.26W.

(Joins lower right)

CHERRY COUNTY

R.26W.

15

N

T.24N.

T.24N.

(Joins sheet 14)

(Joins sheet 7)

BLAINE COUNTY

BLAINE COUNTY

(Joins inset, sheet 30)

(Joins upper left)

West Purdum School

NORTH LOUP RIVER

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

16

N

(Joins sheet 8)

R.30W.

T.23N.

(Joins sheet 17)

HOOKER COUNTY

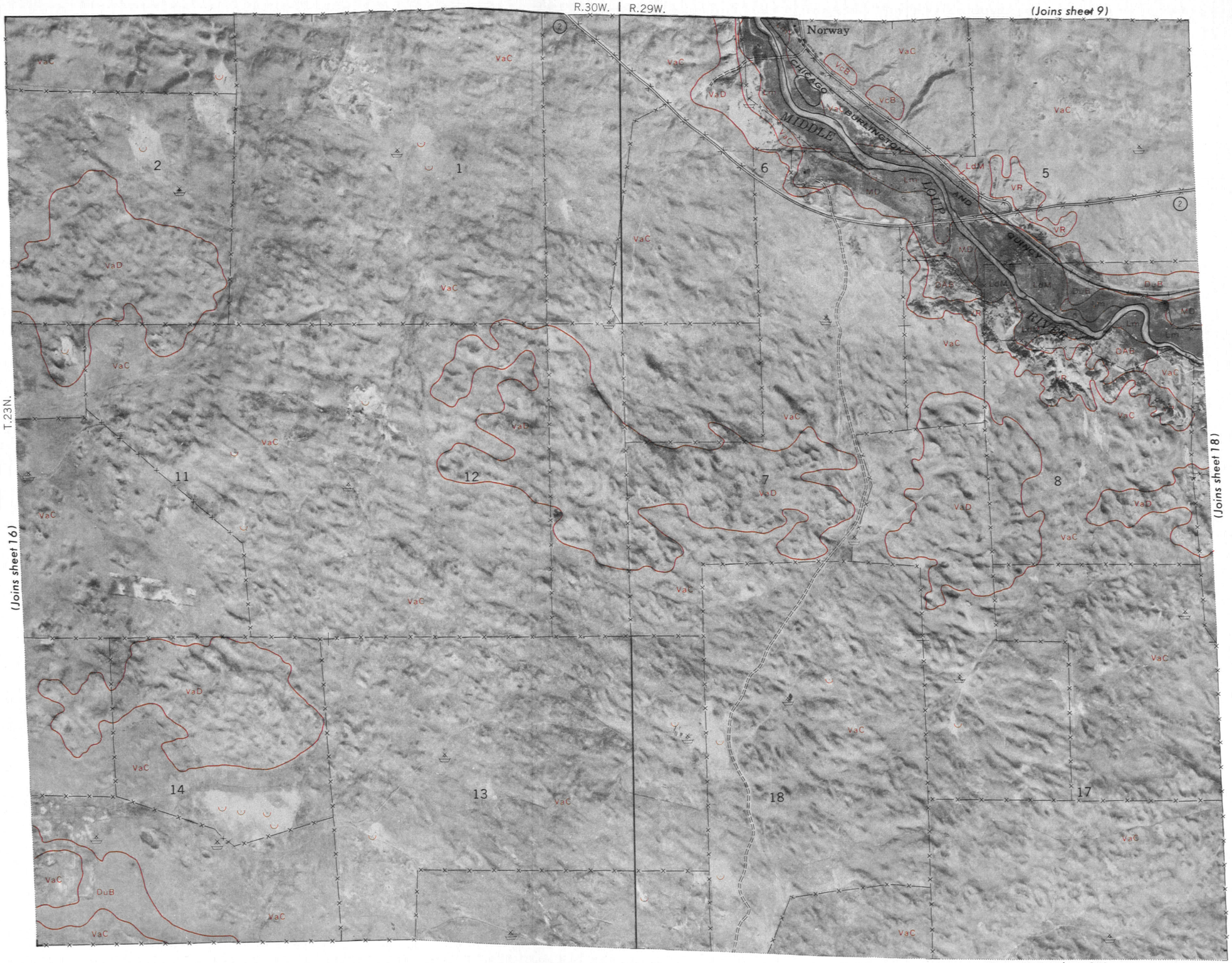
(Joins sheet 23)

Madron School

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet



17

N

This map is one of a set compiled in 1964 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Conservation and Survey Division, University of Nebraska.

Range, township, and section corners shown on this map are indefinite.

18

N

(Joins sheet 10)

R.29W.

T.23N.

(Joins sheet 17)

(Joins sheet 19)

(Joins sheet 25)

CHICAGO, BURLINGTON AND QUINCY RAILROAD

MIDDLE LOUP RIVER

QUINCY

4 3 2 1

9 10 11 12

16 15 14 13

VaC VaD VaB DuB LdM Lm MD MDB DAB Wb B Ea

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

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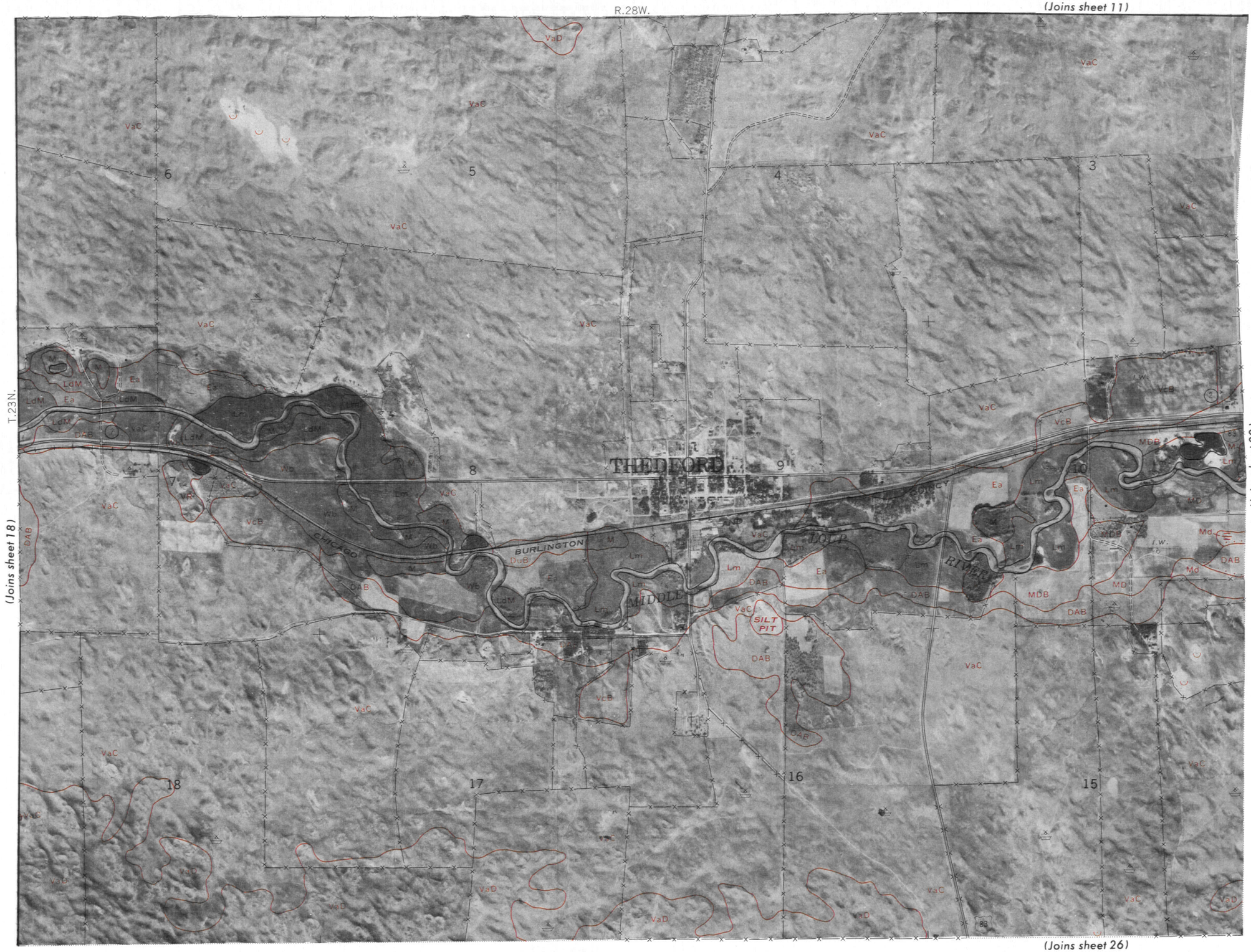


2

CHERRY COUNTY

R.30W. | R.29W.

N

T.24N.

(Joins sheet 1)

(Joins sheet 3)

(Joins sheet 9)

Scale 1:20000

0 ½ 1 Mile

0 5000 Feet

20

N

(Joins sheet 12)

R.28W. | R.27W.

T.23N.

(Joins sheet 19)

(Joins sheet 21)

(Joins sheet 27)

CHICAGO, BURLINGTON AND QUINCY MIDDLE LOUP RIVER

NEBRASKA NATIONAL FOREST

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

R.27W.

(Joins sheet 13)

21

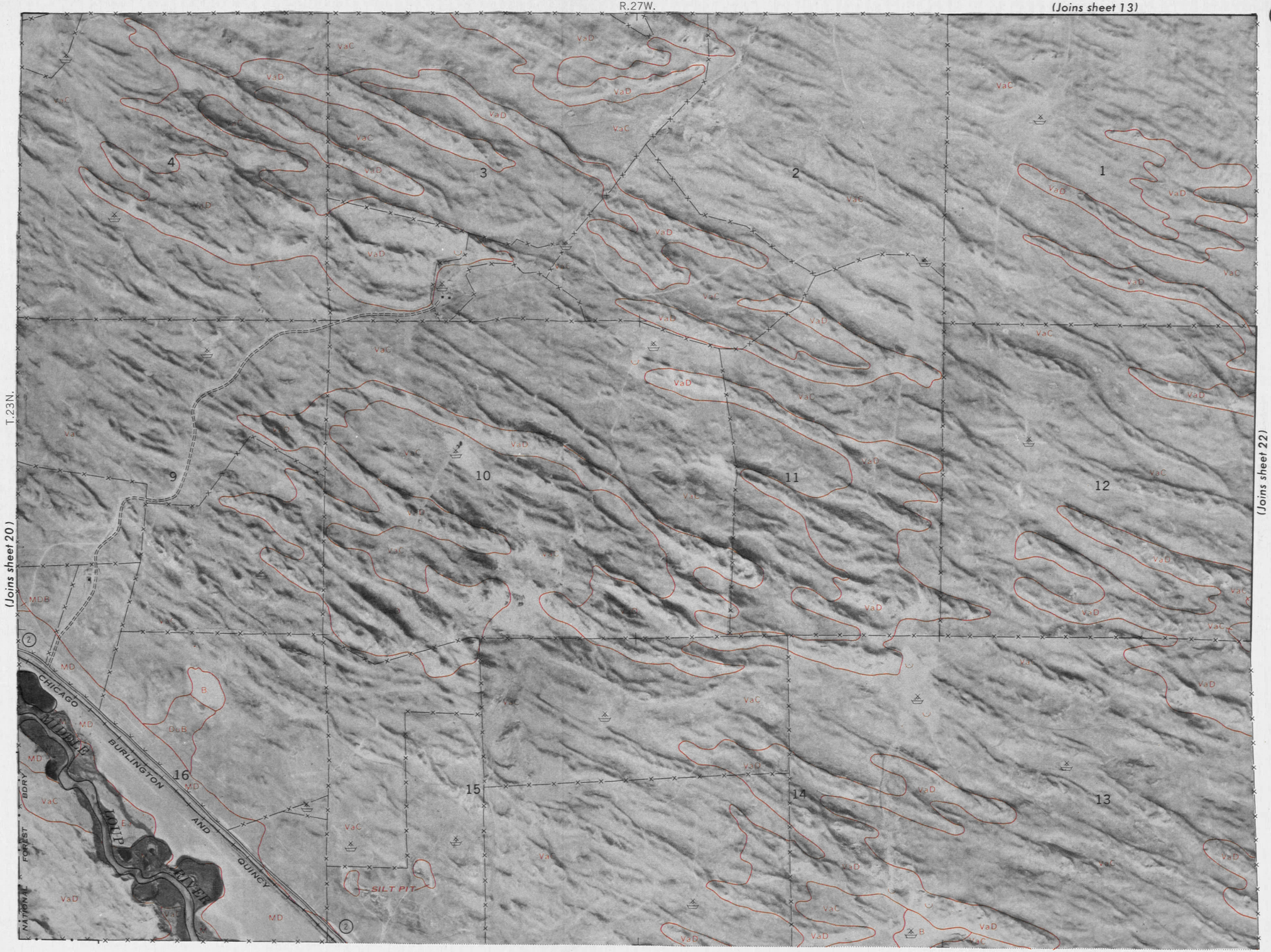
N

T.23N.

(Joins sheet 20)

(Joins sheet 22)

(Joins sheet 28)



0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

22

N

(Joins sheet 14)

R.26W.

T.23N.

(Joins sheet 21)

(Joins inset, sheet 30)

(Joins sheet 29)

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

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R.30W.

(Joins sheet 16)

23

N

T.23N.

HOOKER COUNTY

(Joins sheet 24)

(Joins sheet 31)

Licking School

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

THOMAS COUNTY, NEBRASKA — SHEET NUMBER 24

(24)

N

(Joins sheet 17)

R.30W. | R.29W.

T.23N.

(Joins sheet 23)

(Joins sheet 25)

(Joins sheet 32)

23 24 19 20

26 25 30 29

35 36 31 32

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

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R.29W.

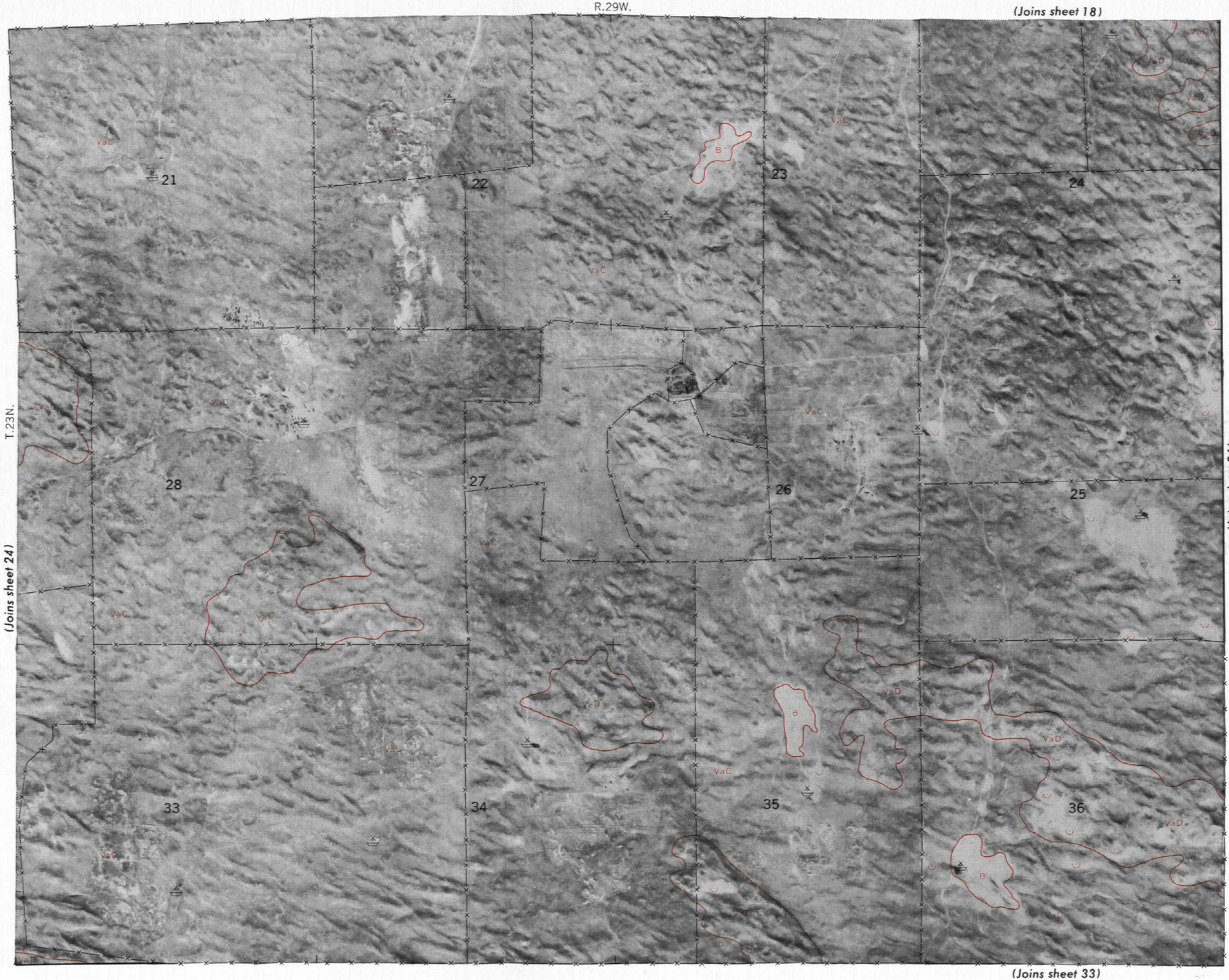
T.23N.

(Joins sheet 18)

(Joins sheet 24)

(Joins sheet 26)

(Joins sheet 33)



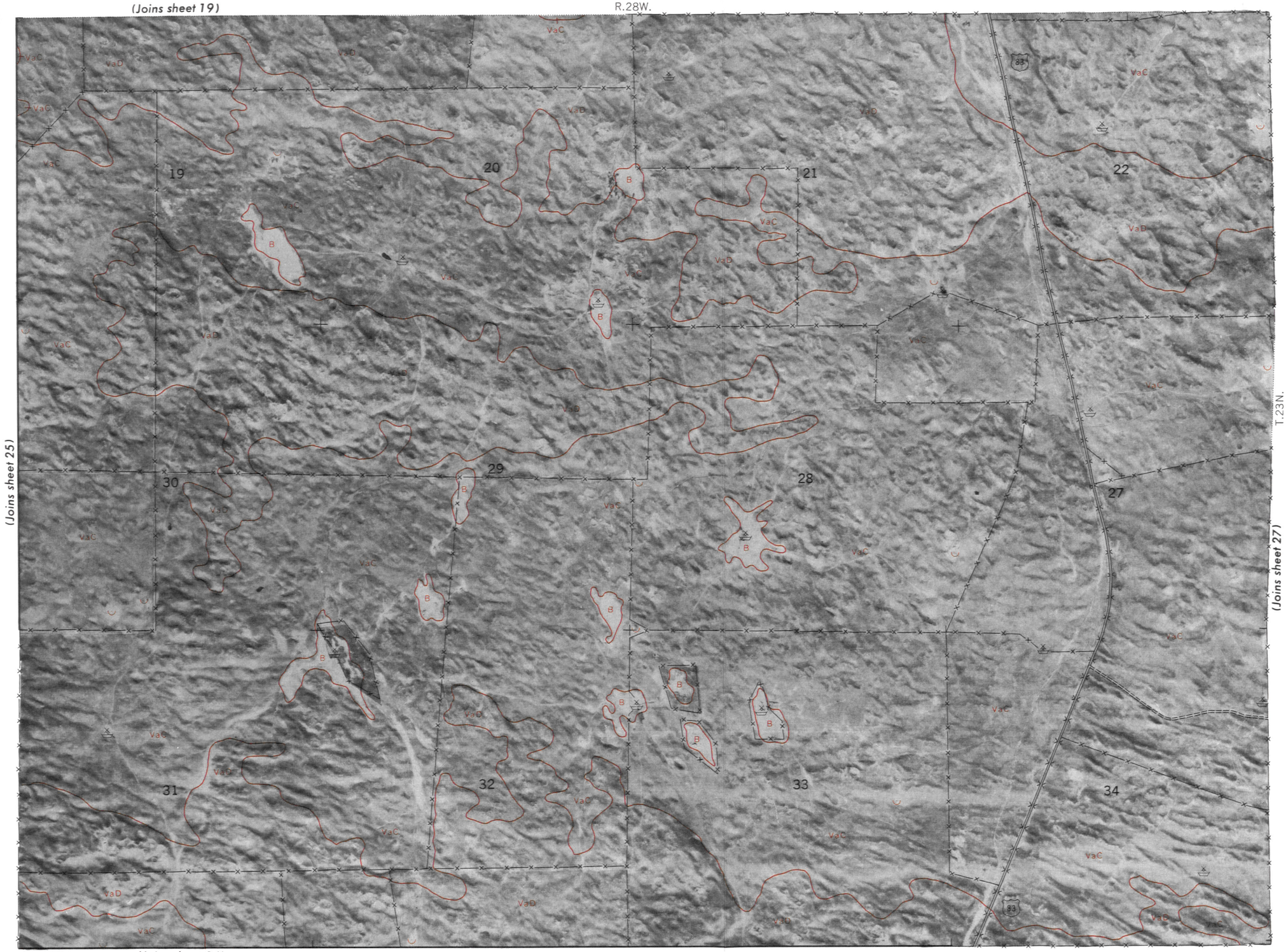
25

N

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet


26
N
(Joins sheet 19)
R.28W.
T.23N.
(Joins sheet 25)
(Joins sheet 27)
(Joins sheet 34)
19
20
21
22
29
28
27
30
31
32
33
34
VaC
VaD
B
83
0
½
1 Mile
Scale 1:20000
0
5000 Feet

THOMAS COUNTY, NEBRASKA — SHEET NUMBER 27

This map is one of a set compiled in 1964 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Conservation and Survey Division, University of Nebraska.

Range, township, and section corners shown on this map are indefinite.

R.28W. | R.27W.

(Joins sheet 20)

27

N

T.23N.

(Joins sheet 26)

(Joins sheet 28)

(Joins sheet 35)

NEBRASKA NATIONAL FOREST

23 24 19 20

26 25 30 29

35 36 31 32

VaC VaD B

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

28

N

(Joins sheet 21)

R.27W.

T.23N.

Natick

SAND PIT

CHICAGO

BURLINGTON

MIDDLE

LOUP

QUINCY

RIVER

NEBRASKA NATIONAL FOREST

21 22 23 24 25 26 27 28 33 34 35 36

(Joins sheet 27)

(Joins sheet 29)

(Joins sheet 36)

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

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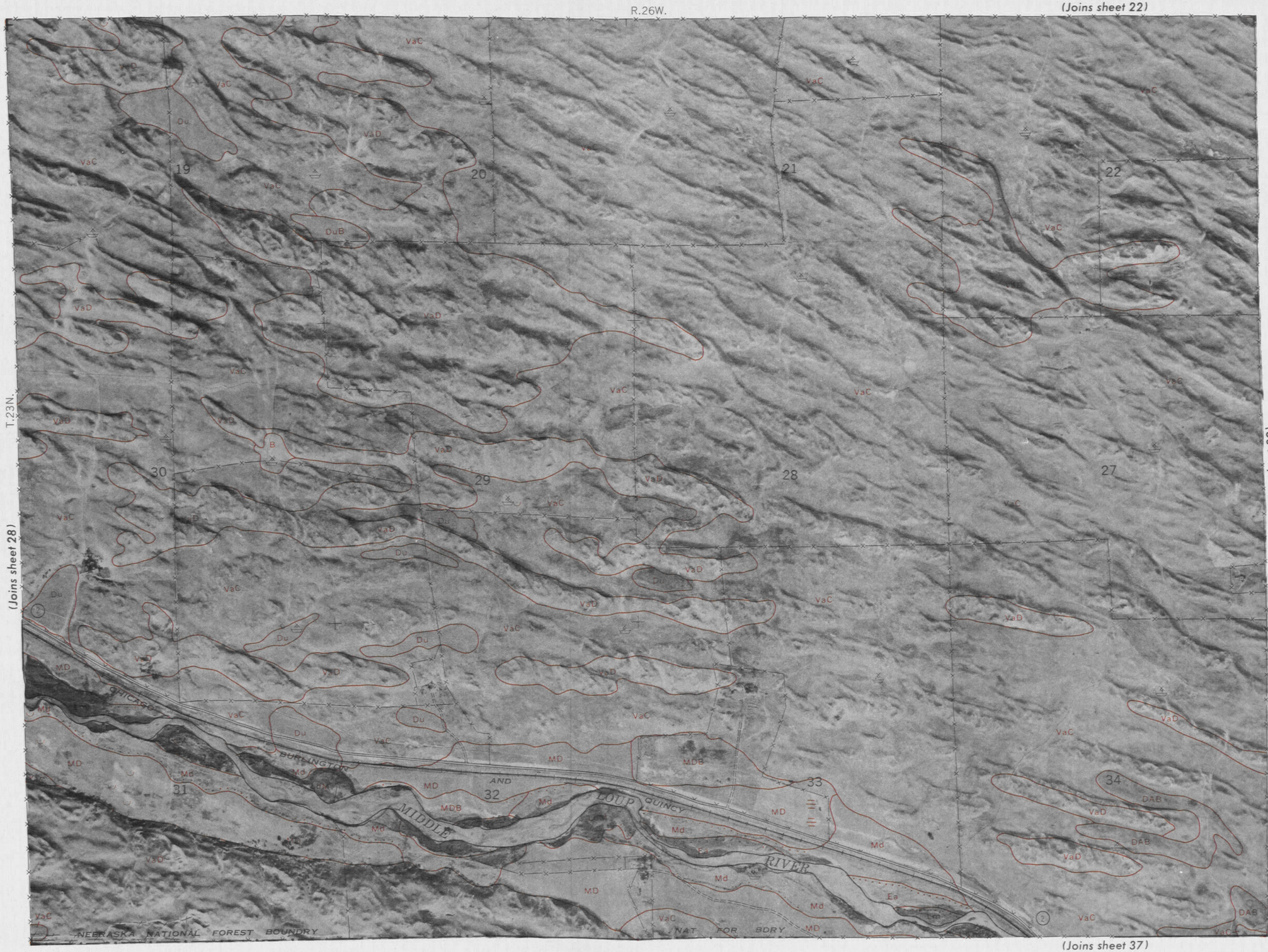
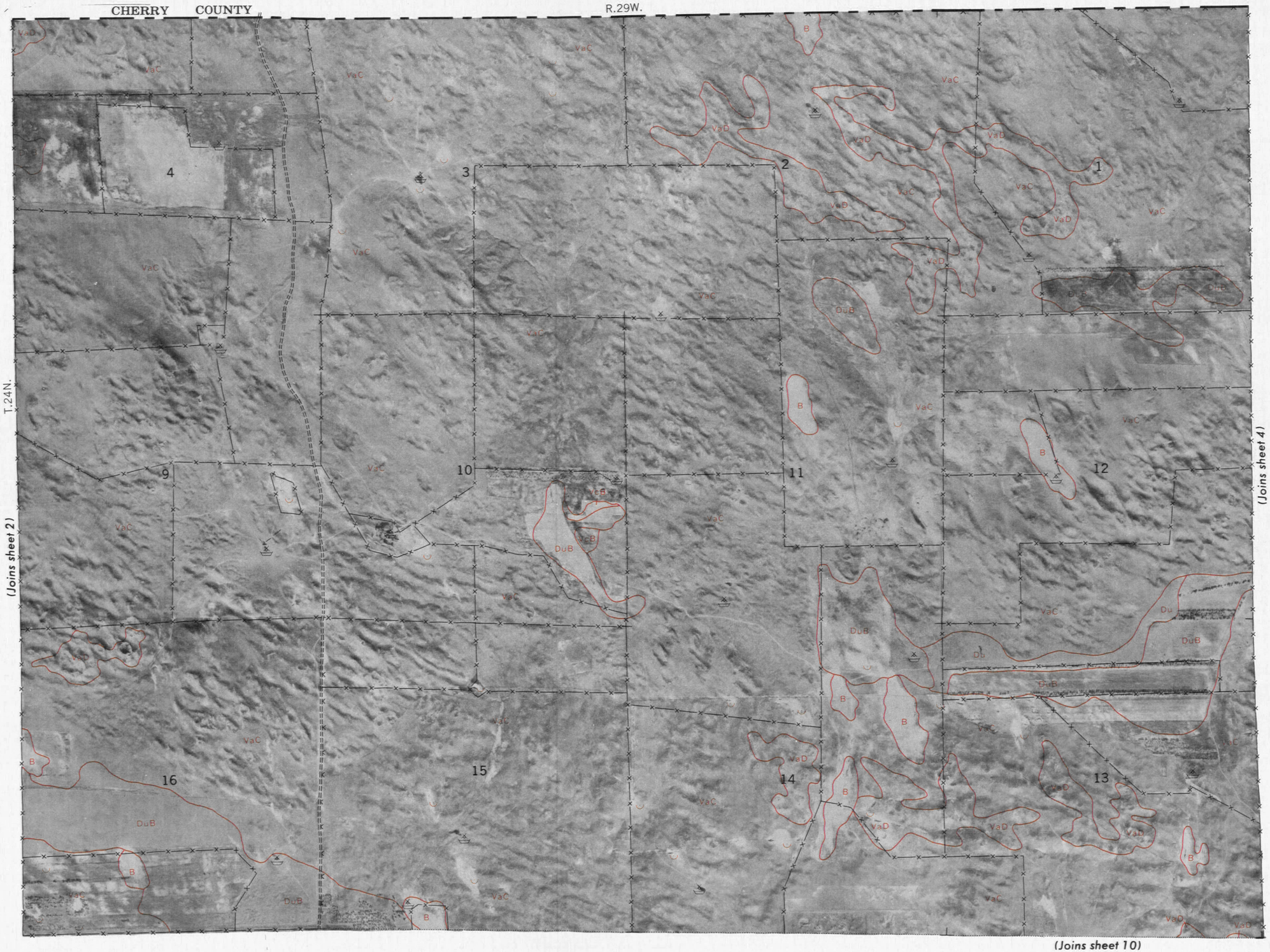


0 ½ 1 Mile Scale 1:20000 0 5000 Feet

Range, township, and section corners shown on this map are indefinite.



0 ½ 1 Mile Scale 1:20000 0 5000 Feet

30

N

(Joins lower right)

R.26W.

T.23N.

BLAINE COUNTY

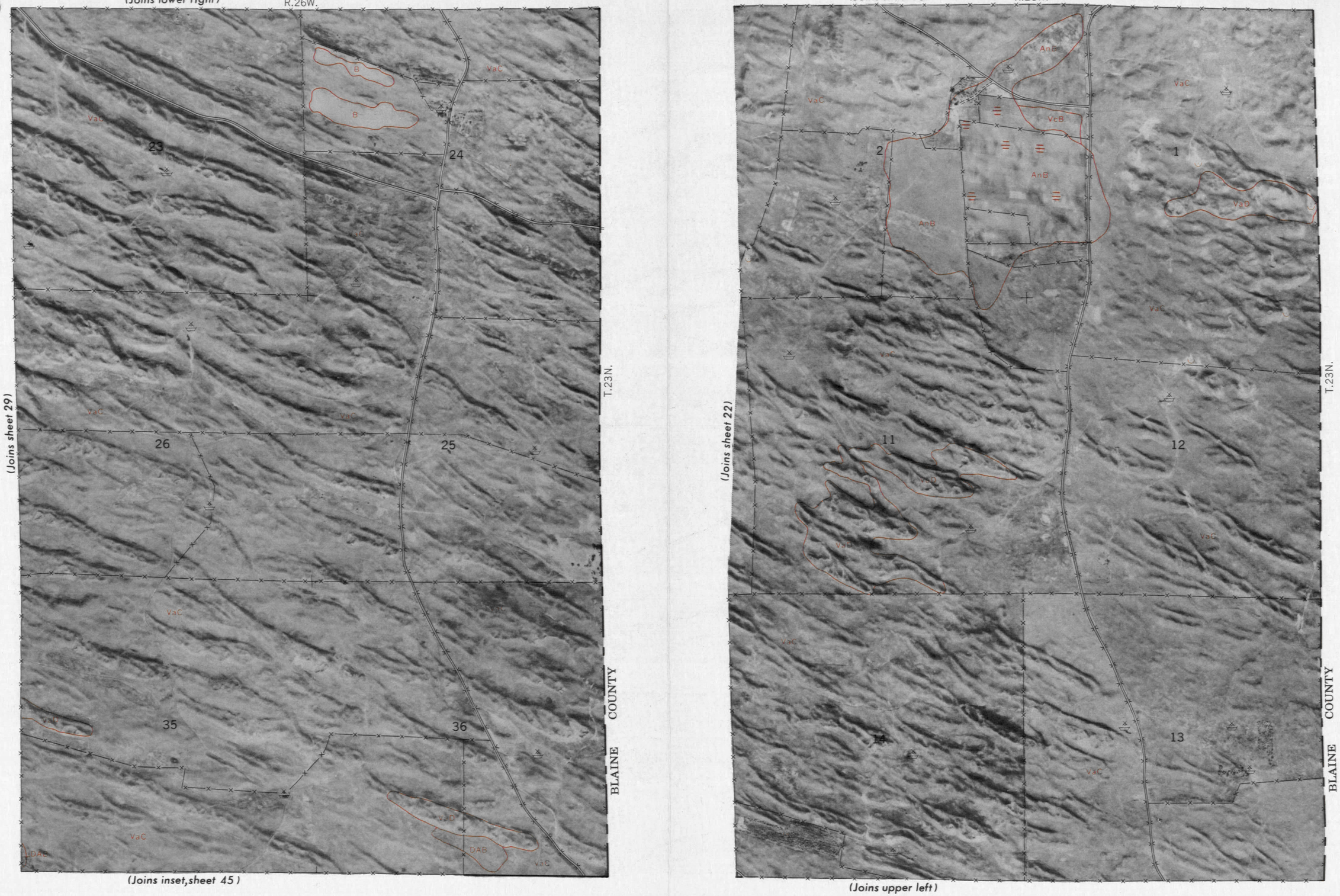
(Joins sheet 29)

(Joins inset, sheet 45)

(Joins sheet 15)

(Joins sheet 22)

(Joins upper left)



0 ½ 1 Mile

Scale 1:20000

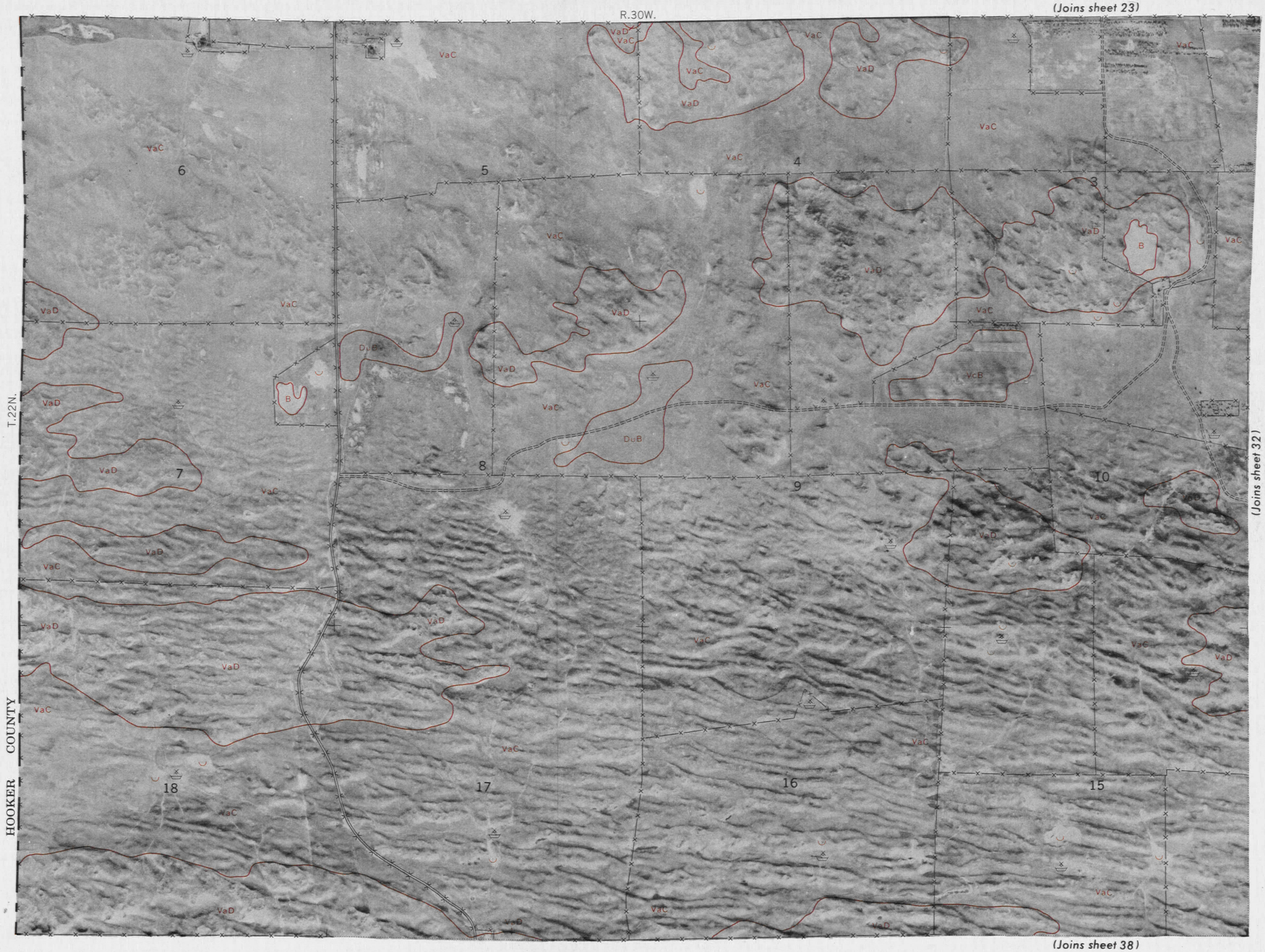
0 5000 Feet

(Joins sheet 23)

R.30W.

T.22N.

HOOKER COUNTY



(Joins sheet 32)

(Joins sheet 38)

N

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

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Range, township, and section corners shown on this map are indefinite.

32

N

(Joins sheet 24)

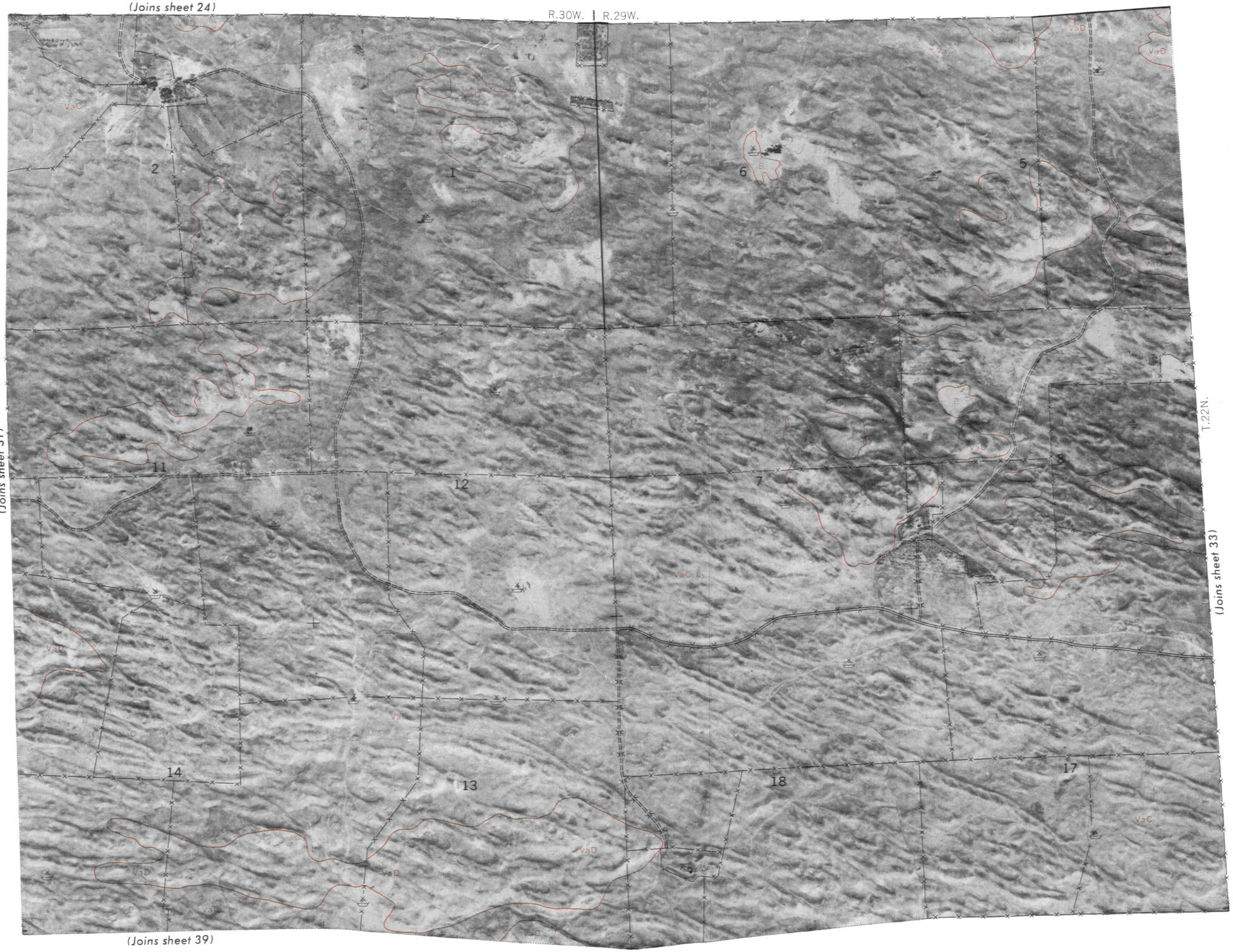
R.30W. | R.29W.

T.22N.

(Joins sheet 31)

(Joins sheet 33)

(Joins sheet 39)



0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

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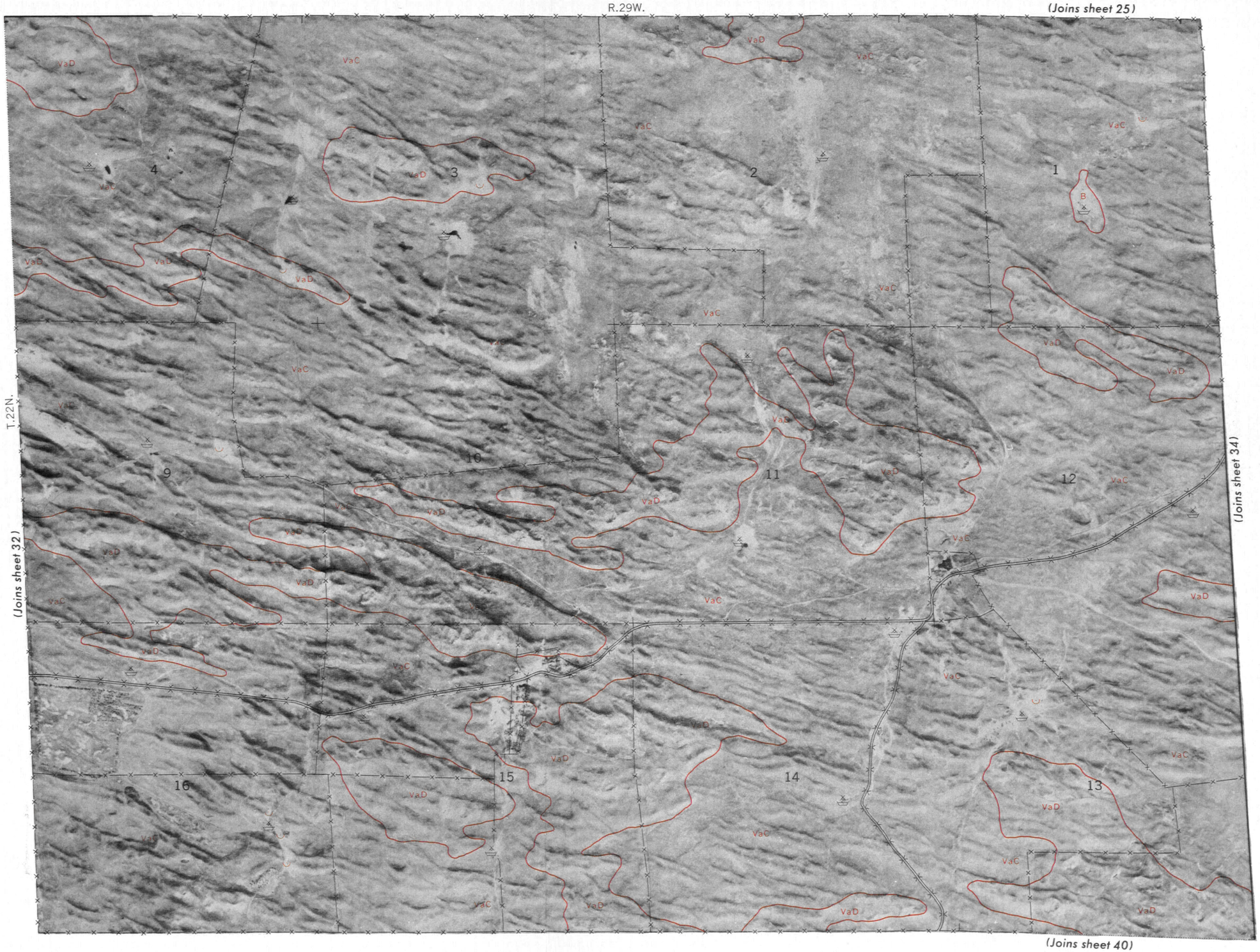


33

N

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

34

(Joins sheet 26)

R.28W.

N

T.22N.

(Joins sheet 33)

(Joins sheet 35)

(Joins sheet 41)

6 5 4 3

7 8 9 10

18 17 16 15

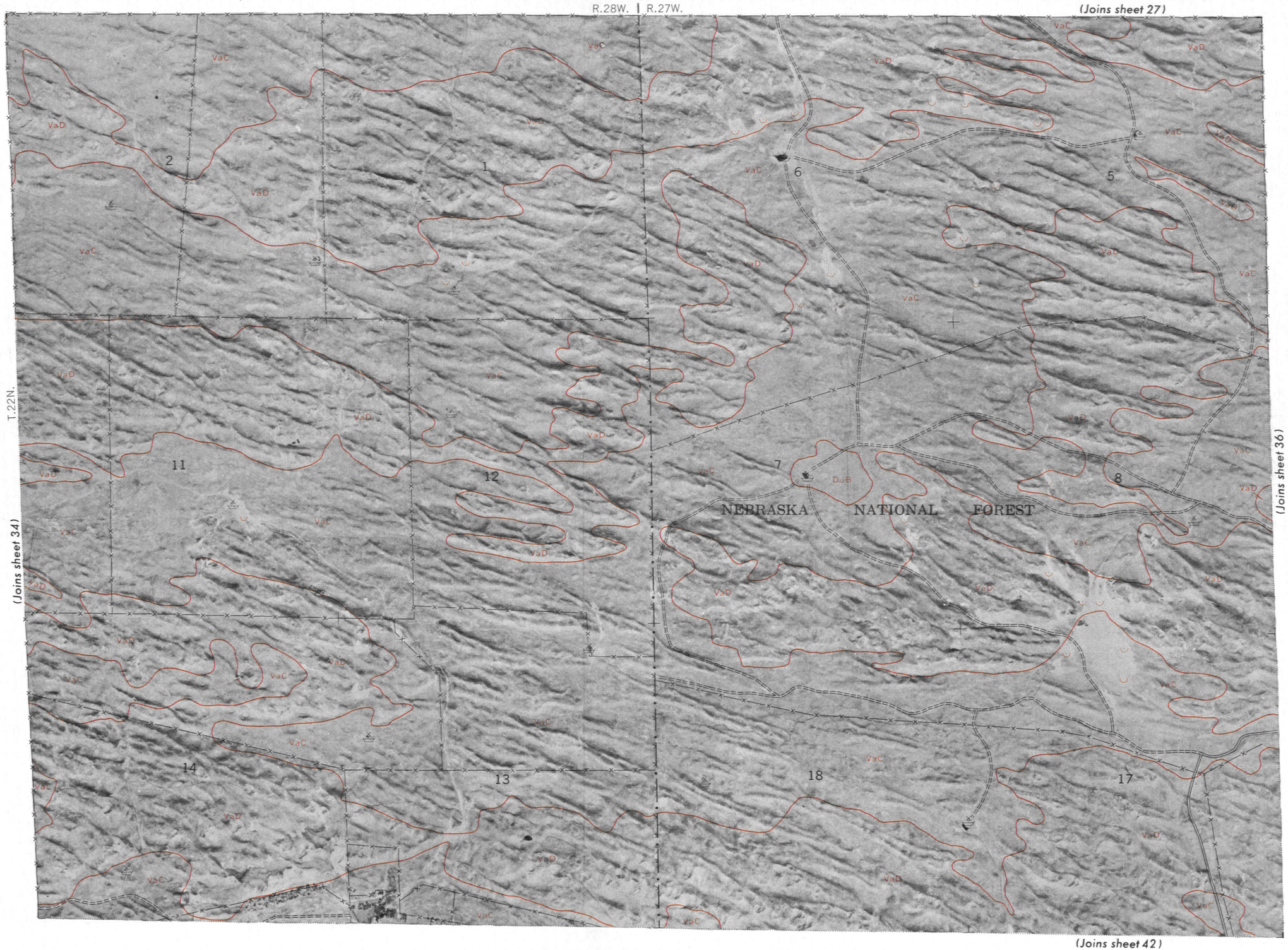
VaC VaD VcB DuB

83

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet



N

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

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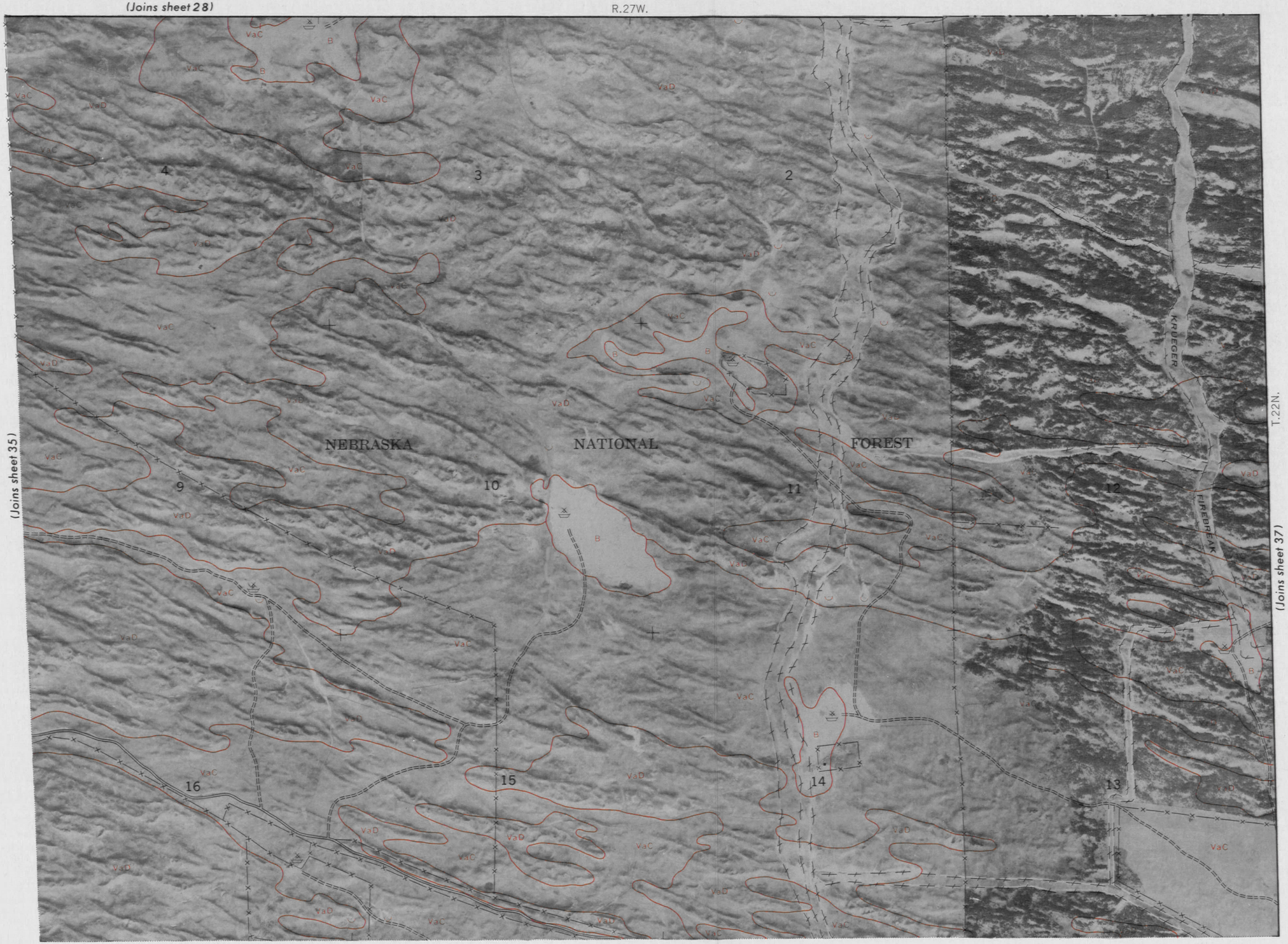
Range, township, and section corners shown on this map are indefinite.

(Joins sheet 28)

R.27W.

(Joins sheet 35)

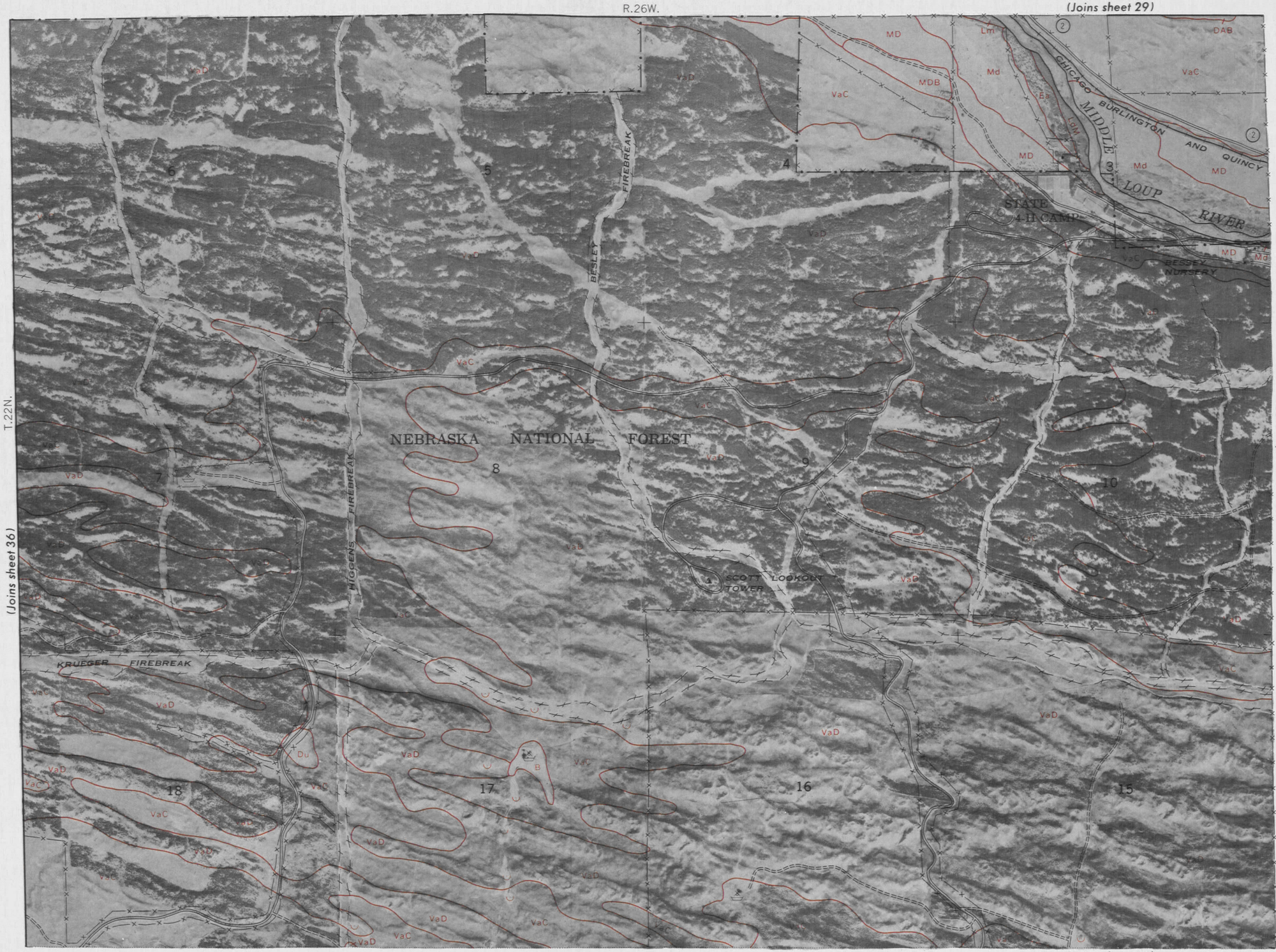


T.22N.

(Joins sheet 37)

(Joins sheet 43)

0 ½ 1 Mile Scale 1:20000 0 5000 Feet



0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

38

(Joins sheet 31)

R.30W.

N

19 20 21 22

30 29 28 27

31 32 33 34

T.22N.

DISMAL RIVER

HOOKER COUNTY

(Joins sheet 39)

(Joins sheet 46)

0 ½ 1 Mile

Scale 1:20000

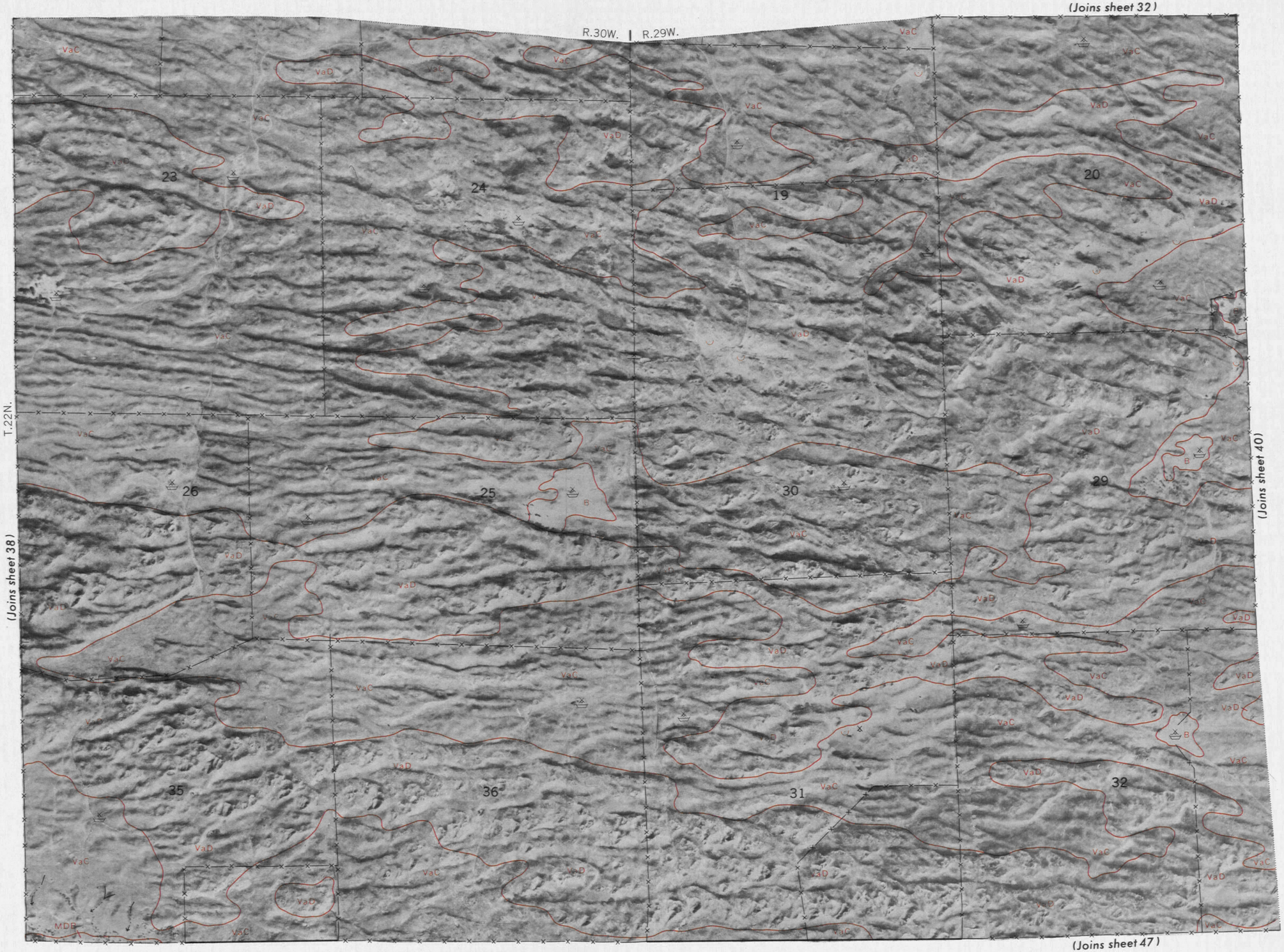
0 5000 Feet

(Joins sheet 32)

N

R.30W. | R.29W.

T.22N.



(Joins sheet 38)

(Joins sheet 40)

(Joins sheet 47)

0 ½ 1 Mile Scale 1:20000 0 5000 Feet

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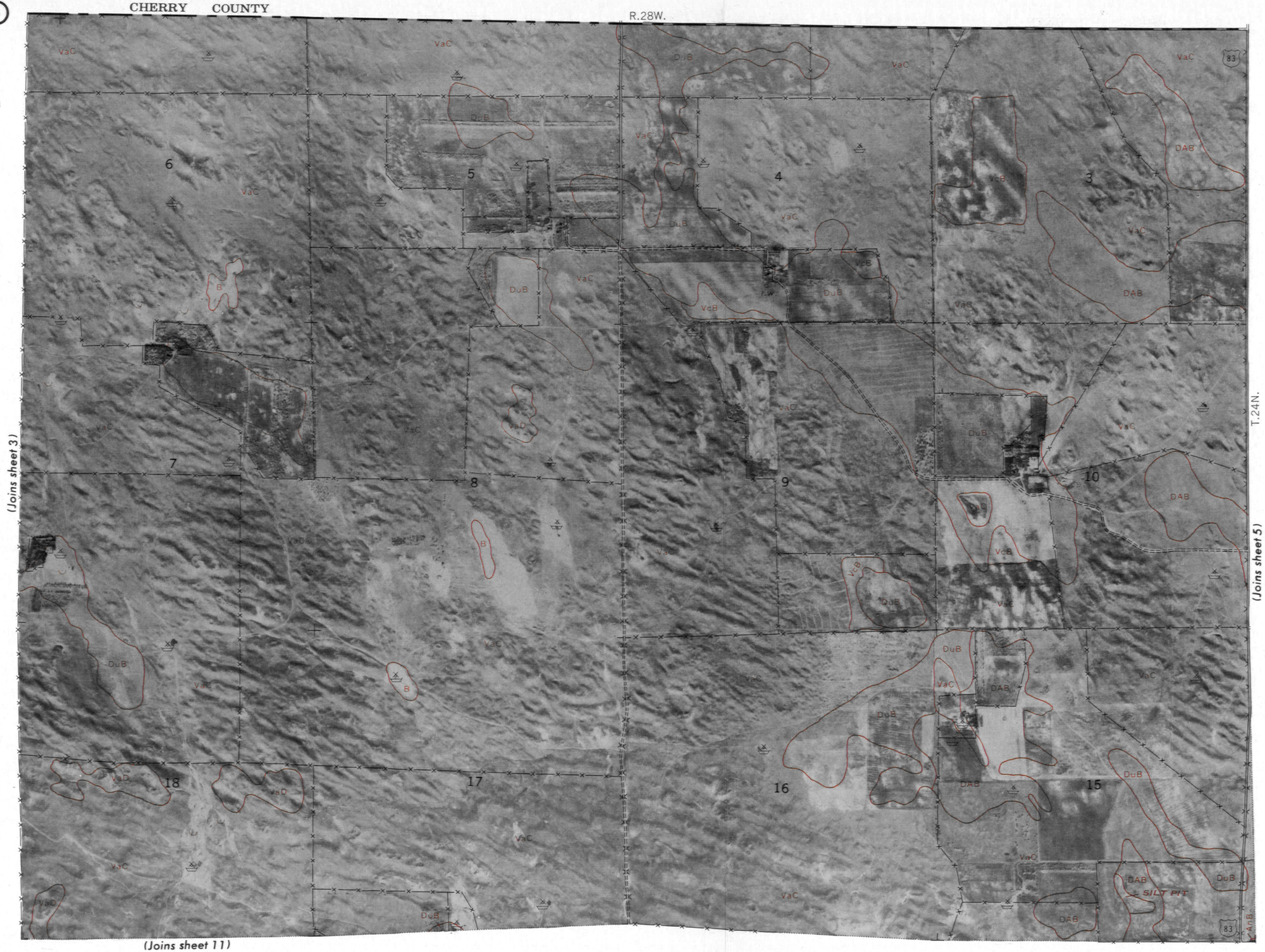
4

CHERRY COUNTY

R.28W.

N



T.24N.

(Joins sheet 3)

(Joins sheet 5)

(Joins sheet 11)

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

40

N

(Joins sheet 33)

R.29W.

T.22N.

(Joins sheet 41)

(Joins sheet 39)

(Joins sheet 48)

21 22 23 24

28 27 26 25

33 34 35 36

VaC VaD B

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

This map is one of a set compiled in 1964 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Conservation and Survey Division, University of Nebraska.

Range, township, and section corners shown on this map are indefinite.

R.28W.

(Joins sheet 34)

T.22N.

(Joins sheet 40)

(Joins sheet 42)

(Joins sheet 49)

N

Scale 1:20000

0 ½ 1 Mile

0 5000 Feet

42

N

(Joins sheet 35)

R.28W. | R.27W.

T.22N.

Ewoldt School

NEBRASKA NATIONAL FOREST

23 24 19 20

26 25 30 29

35 36 31 32

VaC VaD DuB B

(Joins sheet 41)

(Joins sheet 43)

(Joins sheet 50)

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

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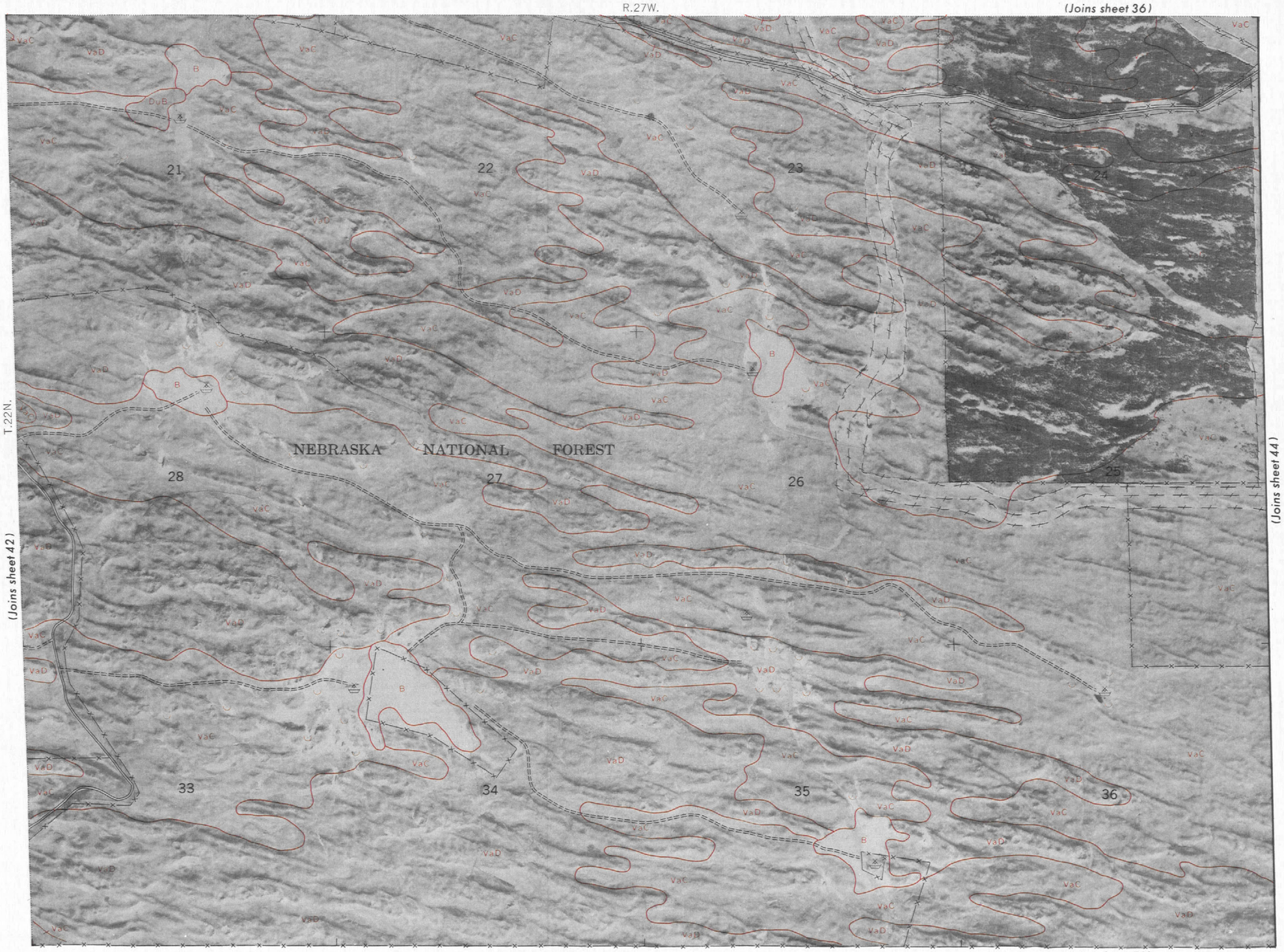

0 ½ 1 Mile Scale 1:20000 0 5000 Feet

(44)

N

(Joins sheet 37)

R.26W.

T.22N.

LUBBE FIREBREAK

NEBRASKA NATIONAL FOREST

FIREBREAK

SOUTH BLOCK 3

NELSON FIREBREAK

19 20 21 22

30 29 28 27

31 32 33 34

VaC VaD B

(Joins sheet 43)

(Joins sheet 45)

(Joins sheet 52)

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

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Range, township, and section corners shown on this map are indefinite.

R.26W. (Joins lower right)

T.22N.

(Joins sheet 44)

NEBRASKA NATIONAL FOREST

NELSON FIREBREAK

BLAINE COUNTY

(Joins inset, sheet 60)

R.26W. (Joins sheet 30)

(45)

N

CHICAGO BURLINGTON AND QUINCY

Halsey

BESSEY NURSERY

MIDDLE LOUP RIVER

T.22N.

(Joins sheet 37)

NEBRASKA NATIONAL FOREST

BLAINE COUNTY

(Joins upper left)

0 ½ 1 Mile

Scale 1:20000

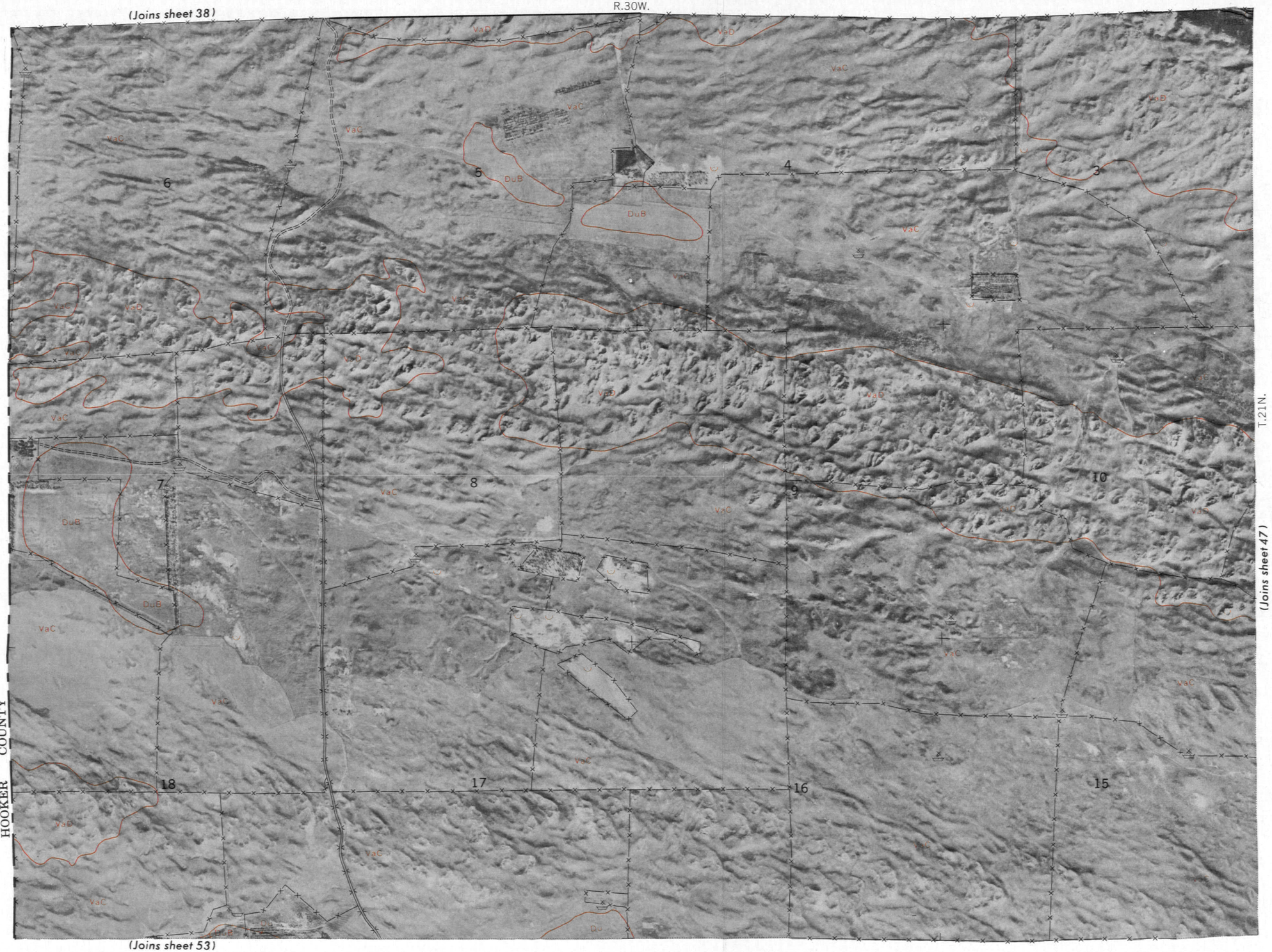
0 5000 Feet

46

N

R.30W.

(Joins sheet 38)



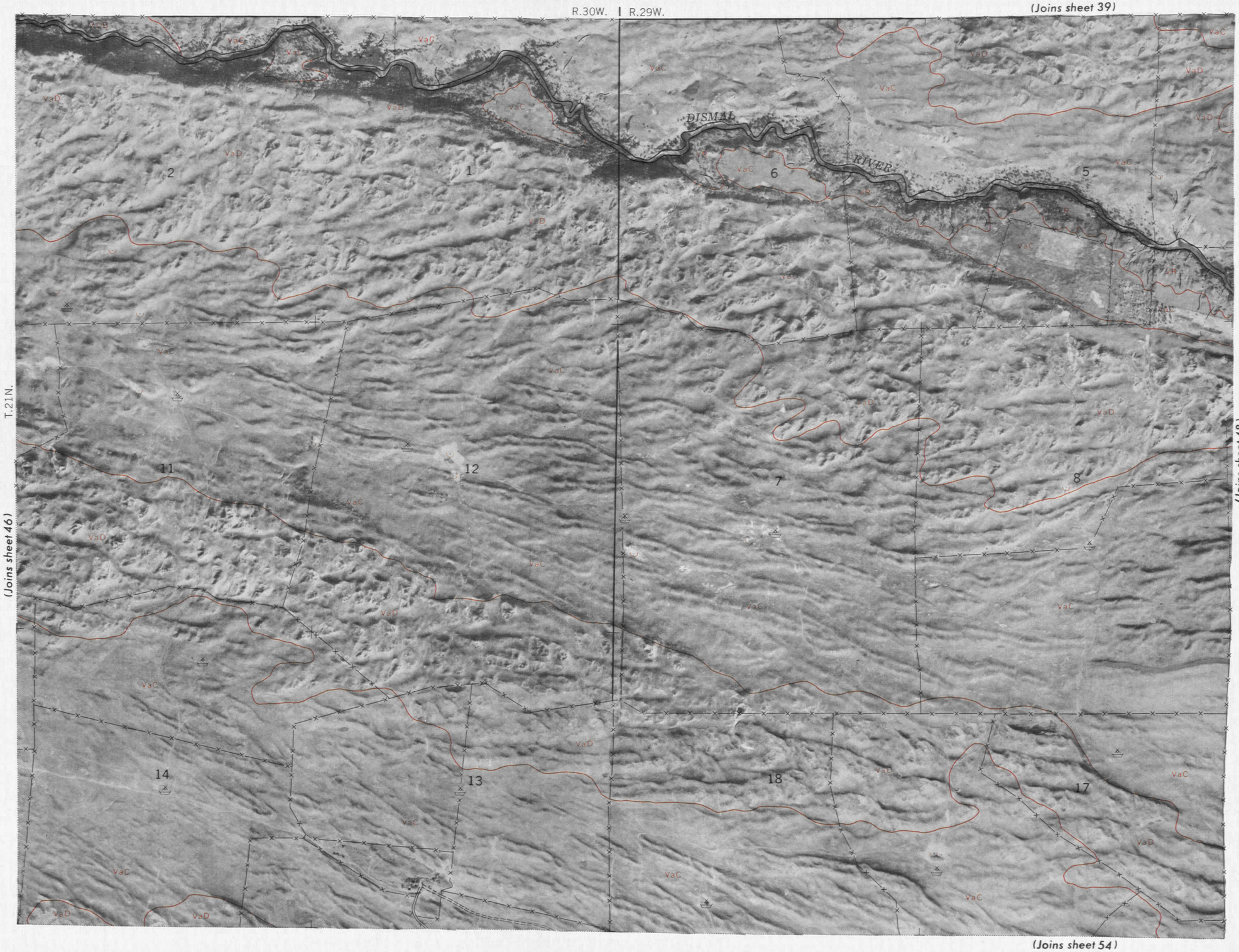
T.21N.

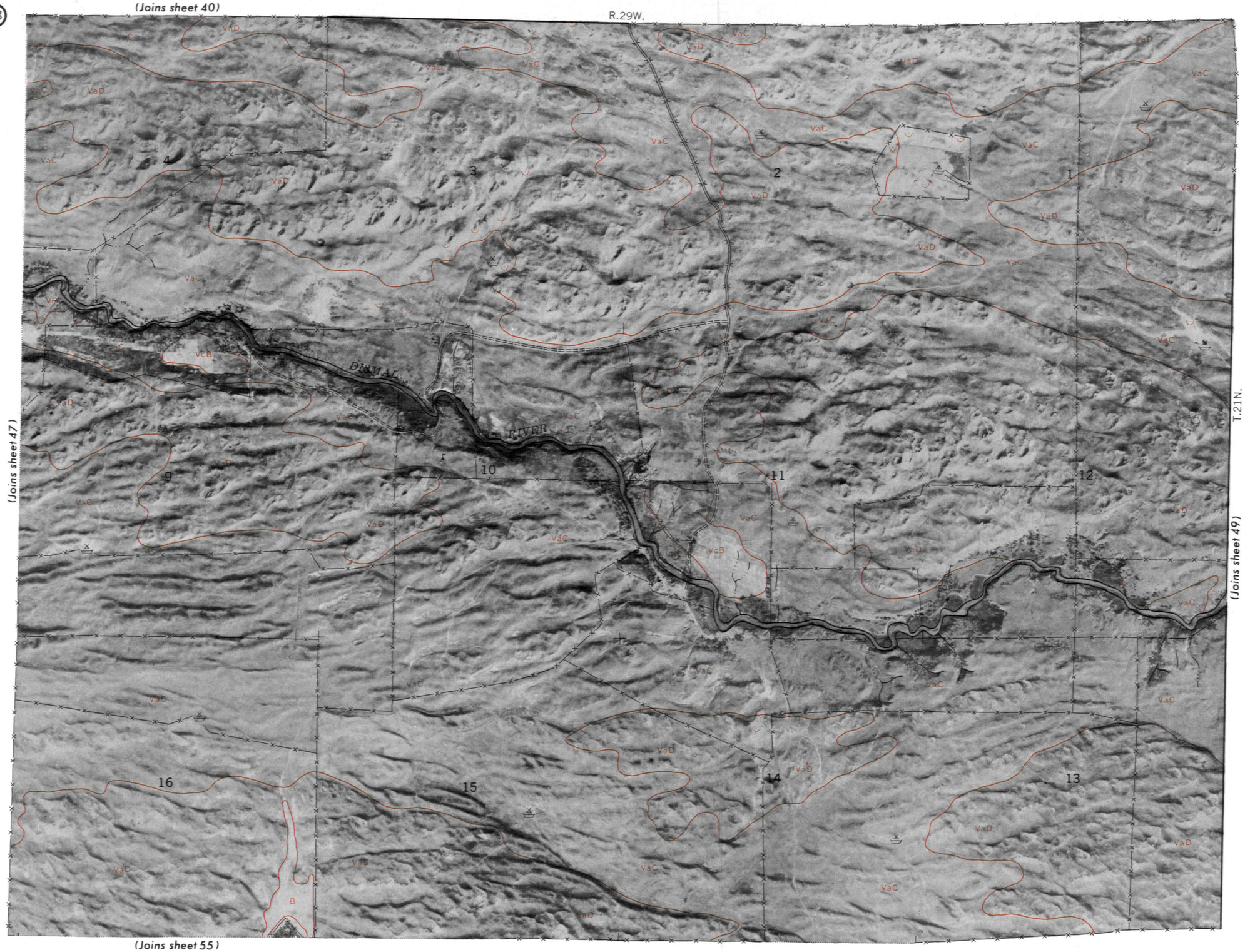
(Joins sheet 47)

HOOKER COUNTY

(Joins sheet 53)

0 ½ 1 Mile Scale 1:20000 0 5000 Feet




48
(Joins sheet 40)
R.29W.
N
T.21N.
(Joins sheet 47)
(Joins sheet 49)
(Joins sheet 55)
DISMAL
RIVER
1
2
3
4
9
10
11
12
13
14
15
16
VaC
VaD
VcB
B
0
½
1 Mile
Scale 1:20000
0
5000 Feet

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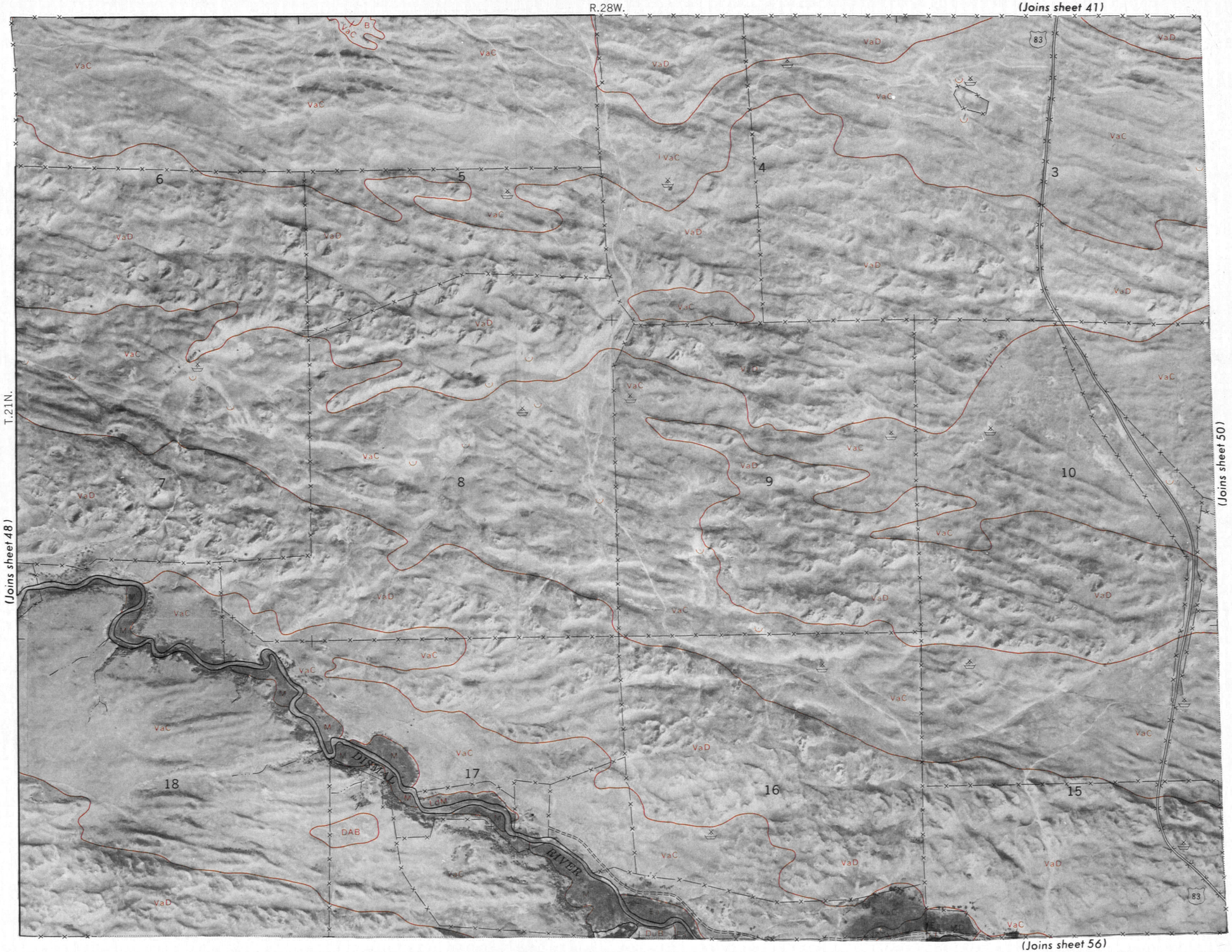

0 ½ 1 Mile Scale 1:20000 0 5000 Feet

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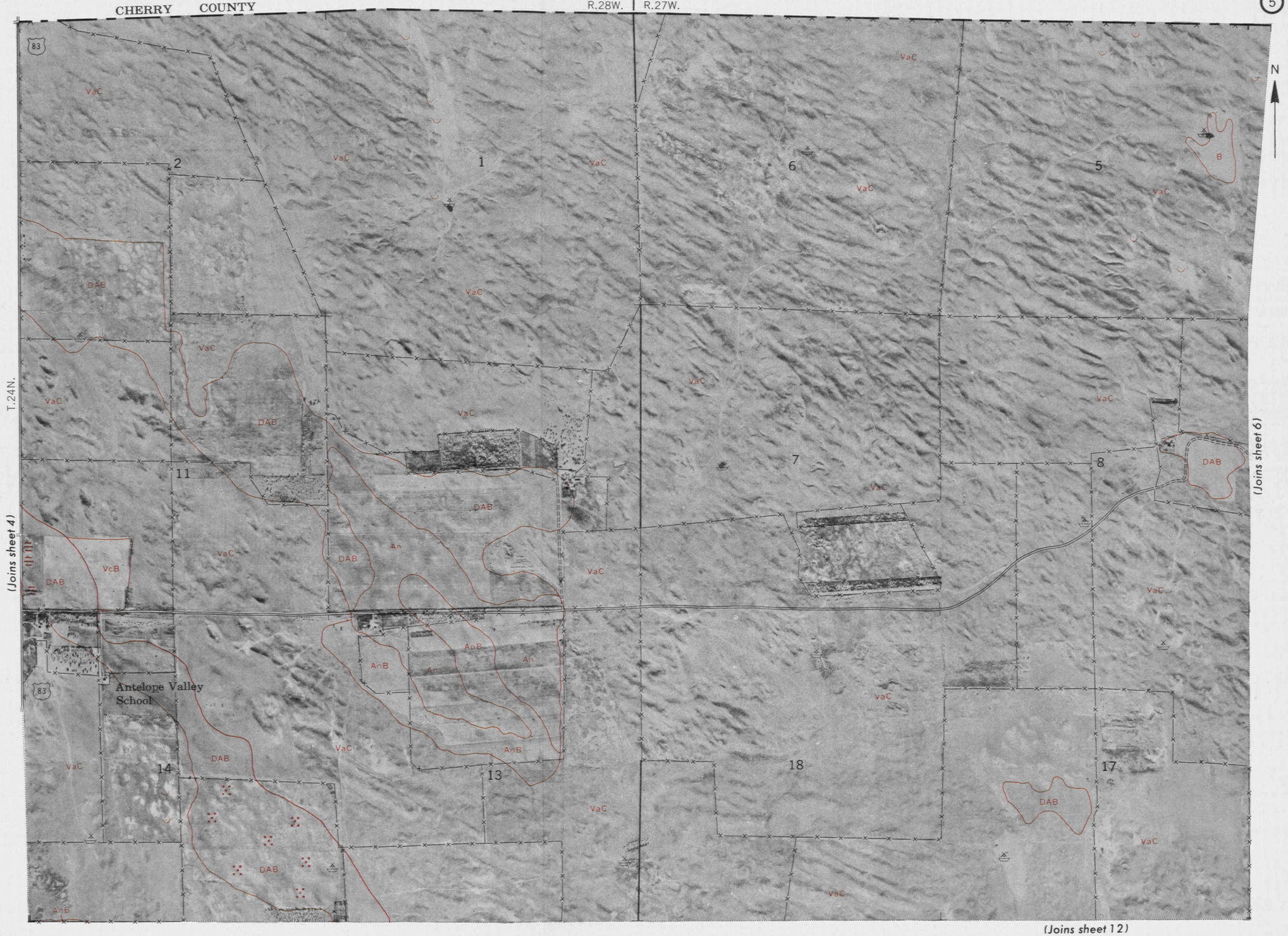
Range, township, and section corners shown on this map are indefinite.



50

N

R.28W. | R.27W.

T.21N.

(Joins sheet 42)

(Joins sheet 49)

(Joins sheet 51)

(Joins sheet 57)

NEBRASKA NATIONAL FOREST

2 1 6 5

11 12 7 8

14 13 18 17

VaC VaD VaB B

83

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

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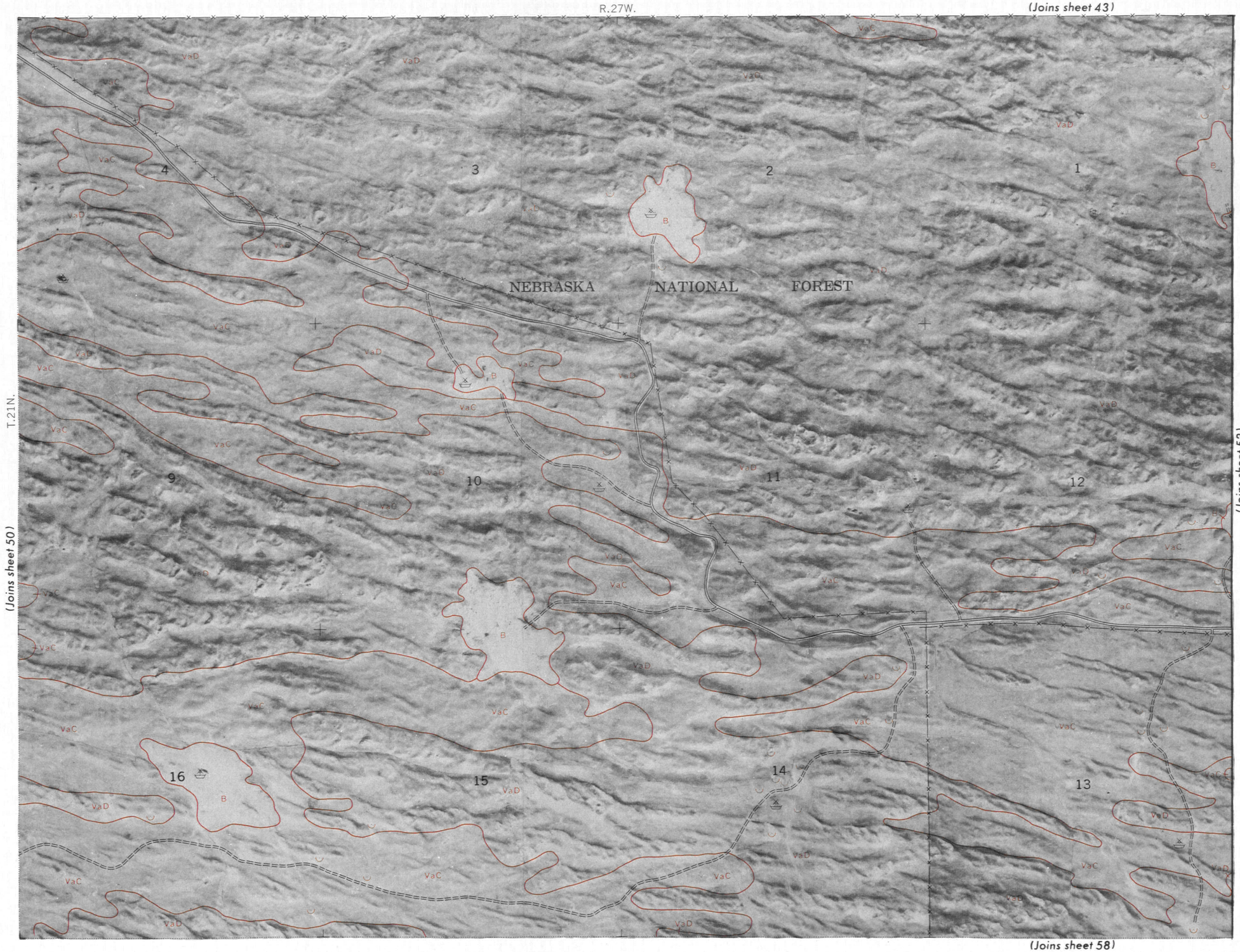


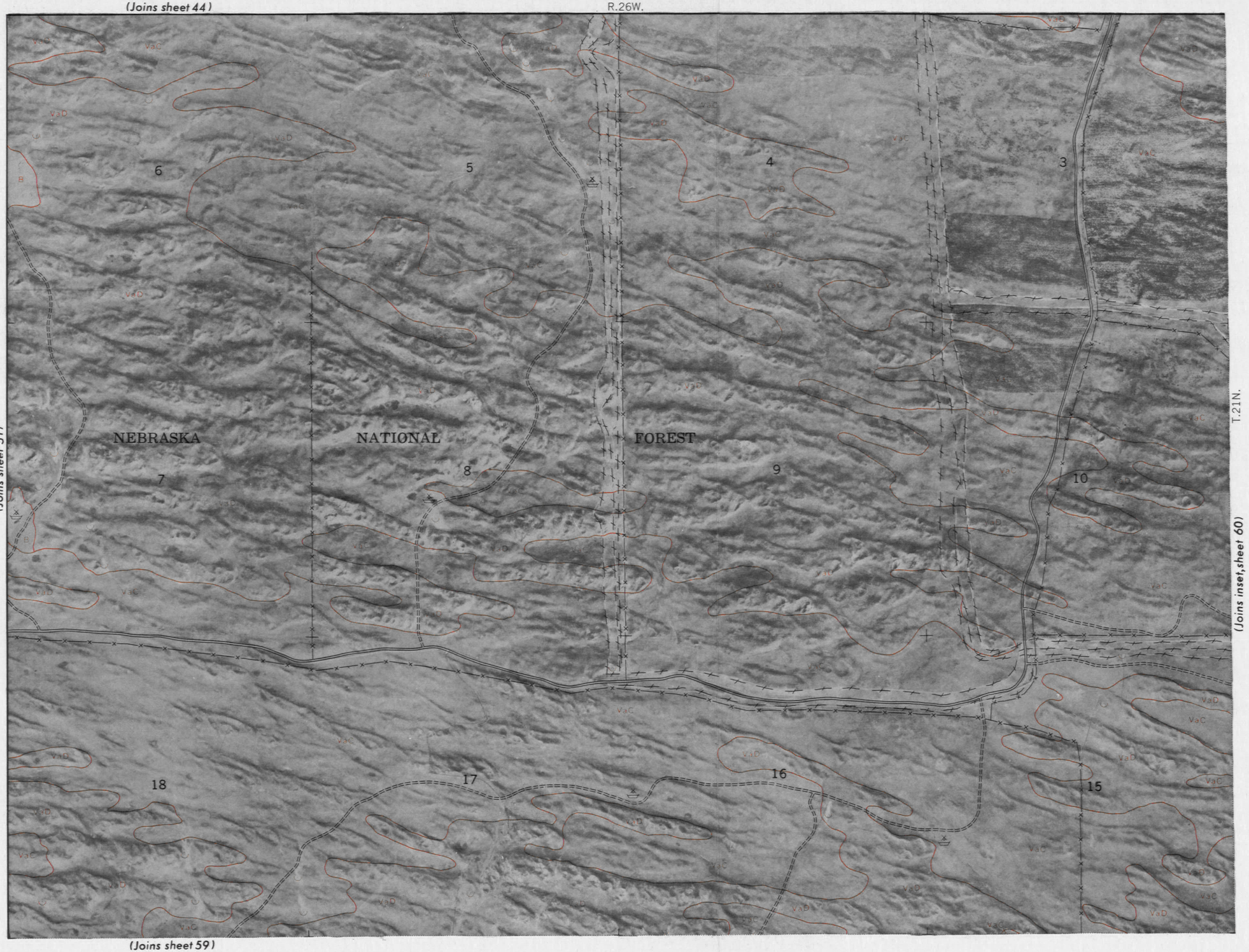
0 ½ 1 Mile Scale 1:20000 0 5000 Feet

52

(Joins sheet 44)

R.26W.

N



T.21N.

(Joins sheet 51)

(Joins inset, sheet 60)

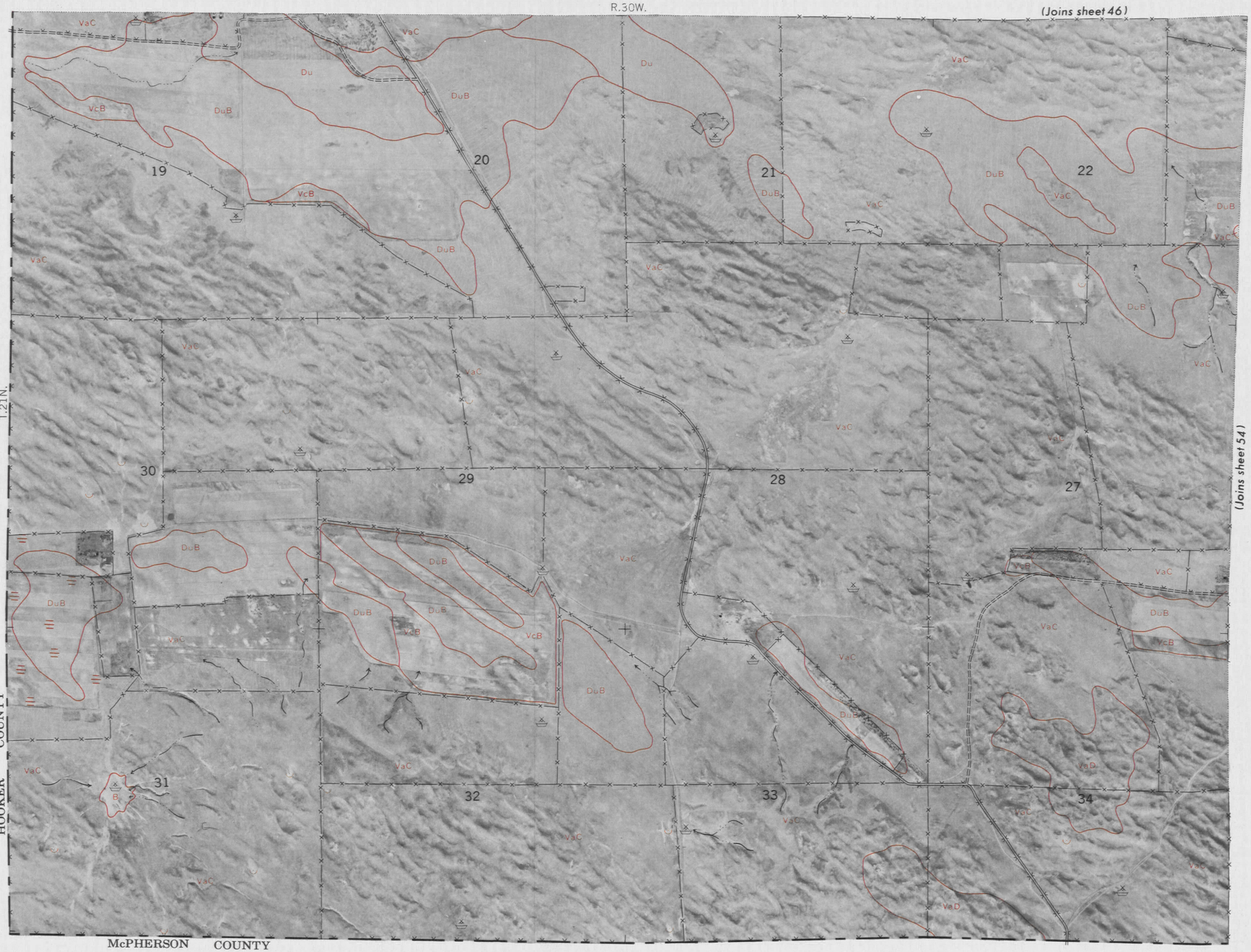
(Joins sheet 59)

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

THOMAS COUNTY, NEBRASKA — SHEET NUMBER 53



0 ½ 1 Mile Scale 1:20000 0 5000 Feet

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54

(Joins sheet 47)

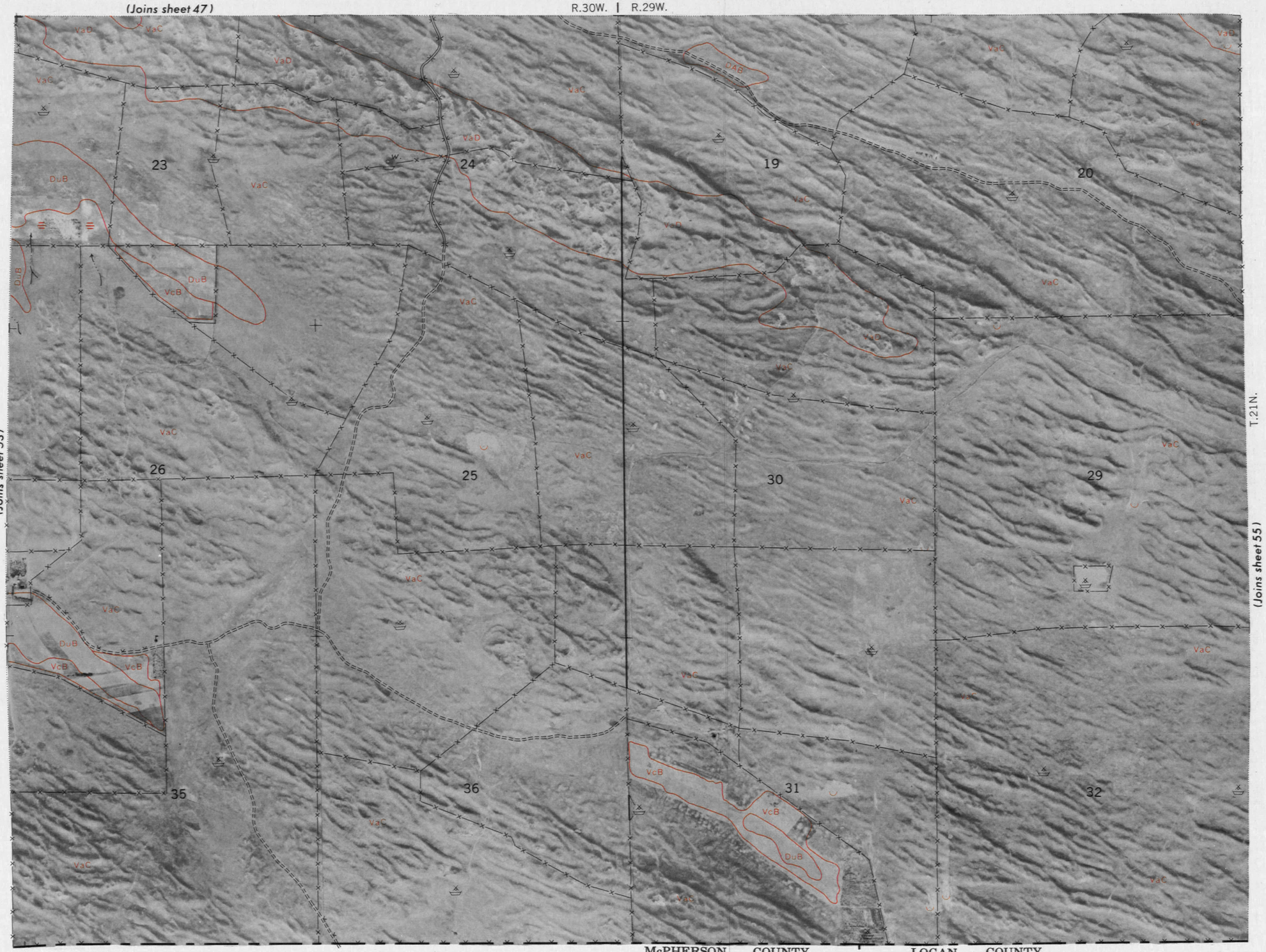
R.30W. | R.29W.

N

T.21N.

(Joins sheet 53)

(Joins sheet 55)



McPHERSON COUNTY | LOGAN COUNTY

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

THOMAS COUNTY, NEBRASKA — SHEET NUMBER 55

R.29W.

(Joins sheet 48)

55

N

T.21N.

(Joins sheet 54)

(Joins sheet 56)

LOGAN COUNTY

21 22 23 24

28 27 26 25

33 34 35 36

VaD VaC DuB DAB Du

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

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56

(Joins sheet 49)

R.28W.

N

DISMAL

PAINE

MD

DAB

VaC

VaD

Ea

Es

B

19 20 21 22

30 29 28 27

31 32 33 34

T.21N.

(Joins sheet 55)

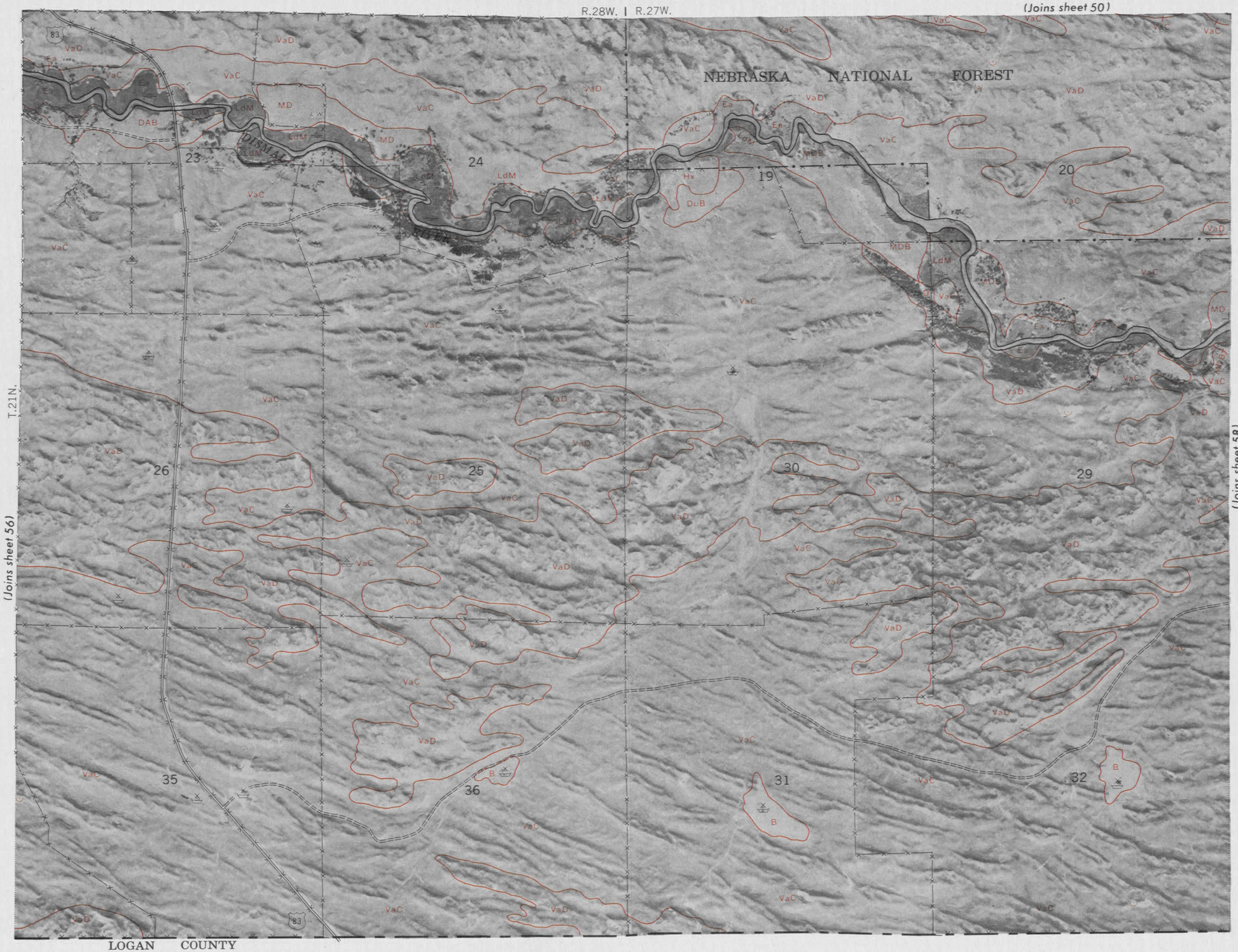
(Joins sheet 57)

LOGAN COUNTY

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet



0 ½ 1 Mile Scale 1:20000 0 5000 Feet

58

(Joins sheet 51)

R.27W.

N

NEBRASKA NATIONAL FOREST

DISMAL RIVER

21 22 23 24

28 27 26 25

33 34 35 36

T.21N.

(Joins sheet 57)

(Joins sheet 59)

LOGAN COUNTY

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

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R.26W.

(Joins sheet 52)

59

N

NEBRASKA NATIONAL FOREST

DISMAL RIVER

DITCH

T.21N.

19 20 21 22

30 29 28 27

31 32 33 34

(Joins sheet 58)

(Joins sheet 60)

LOGAN COUNTY

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

6

CHERRY COUNTY

R.27W.

N

T.24N.

(Joins sheet 5)

(Joins sheet 7)

(Joins sheet 13)

Scale 1:20000

0 ½ 1 Mile

0 5000 Feet

60

N

(Joins lower right)

R.26W.

NEBRASKA NATIONAL FOREST

RIVER

DISMAL

DITCH

23

24

26

25

35

36

T.21N.

BLAINE COUNTY

LOGAN COUNTY

(Joins sheet 59)

0 ½ 1 Mile

Scale 1:20000

(Joins sheet 45)

R.26W.

1

2

11

12

13

14

NEBRASKA NATIONAL FOREST

SILT PIT

RIVER

DISMAL

T.21N.

BLAINE COUNTY

(Joins sheet 52)

(Joins upper left)

0 5000 Feet

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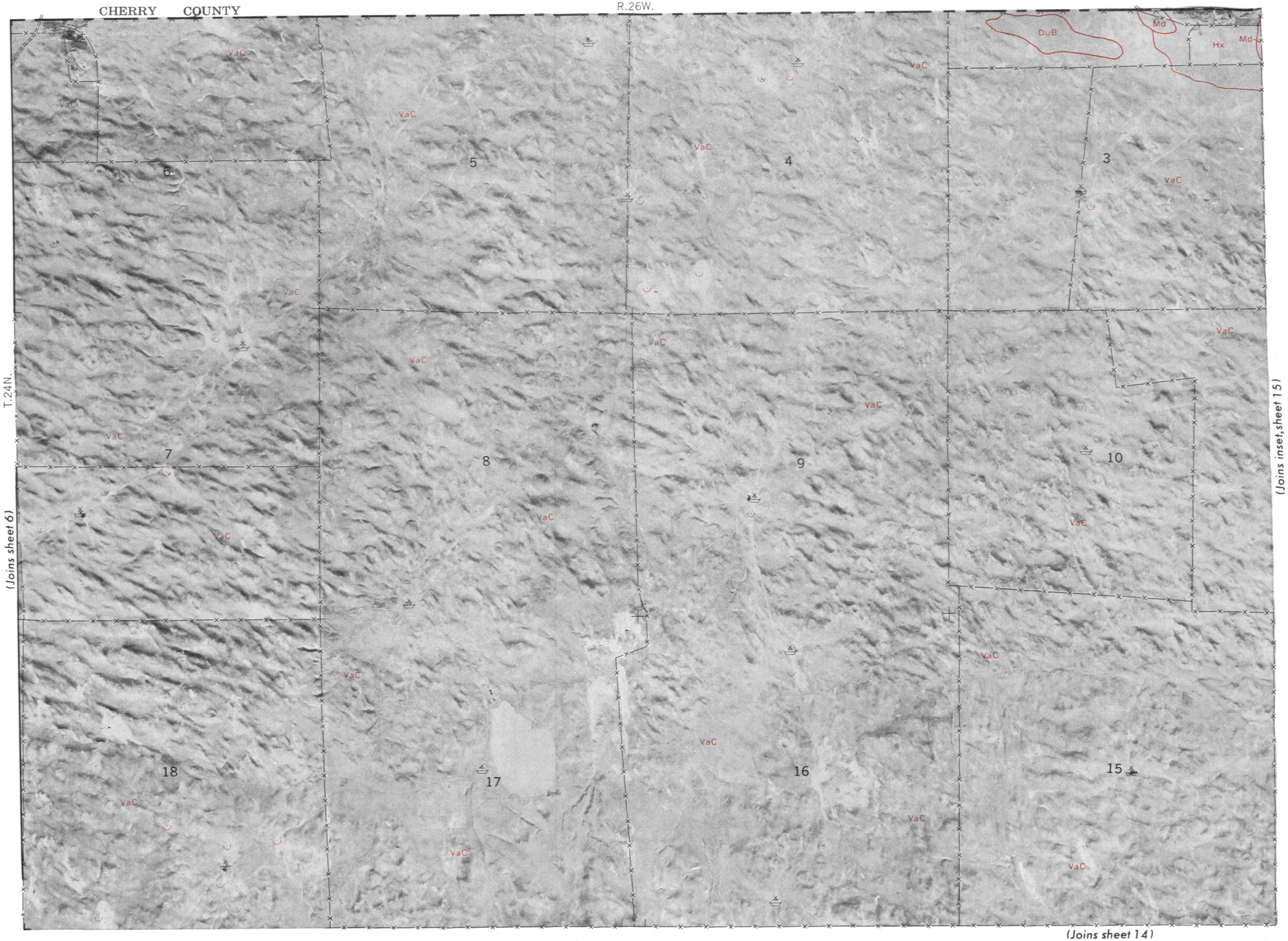
CHERRY COUNTY

R.26W.

T.24N.



(Joins sheet 6)

(Joins inset, sheet 15)

(Joins sheet 14)

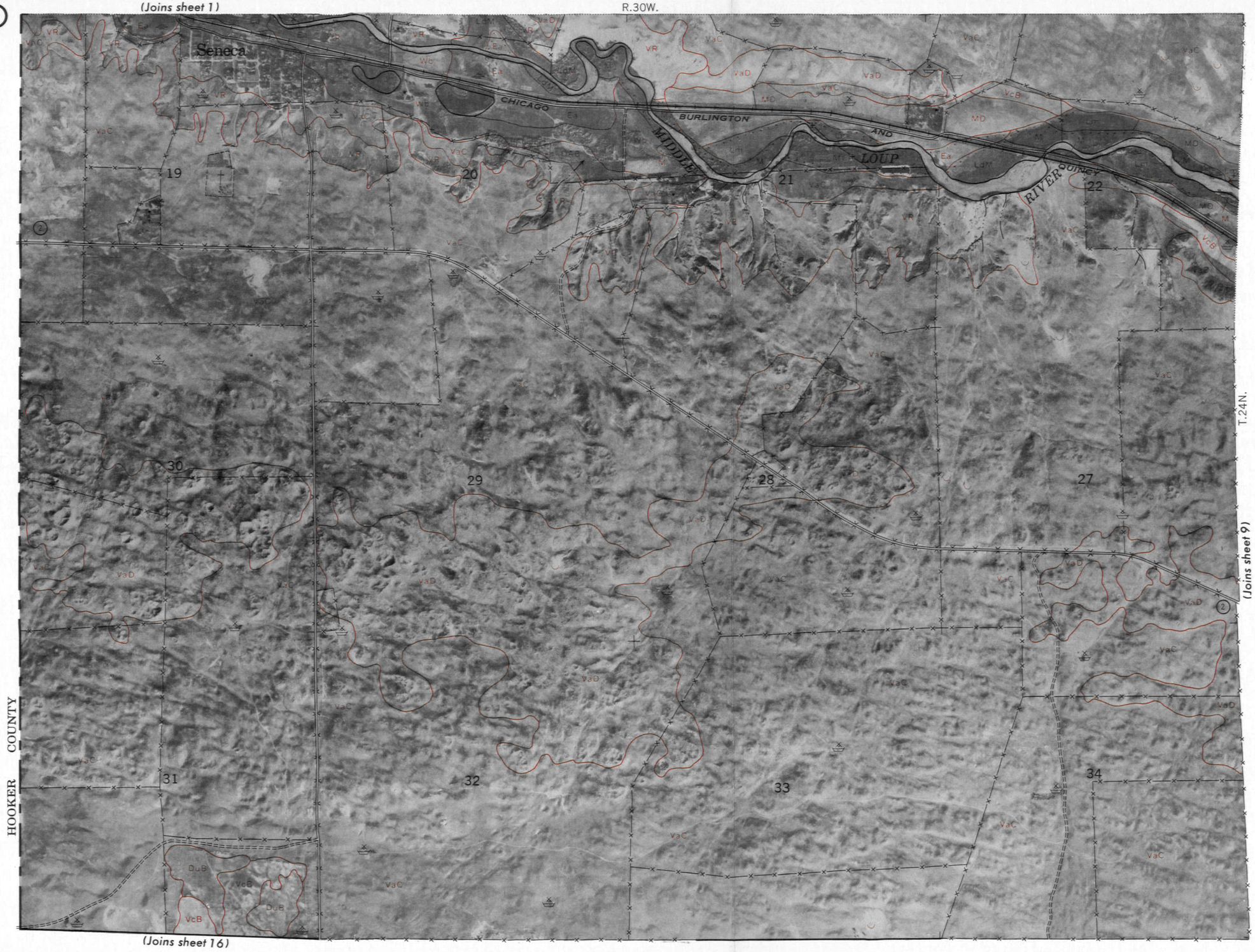
7

N

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet



0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

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